Vol. 9 JANUARY, 1926 No. 1

Journal

of the

American Ceramic Society

Abstracts Bulletin

A Monthly *Journal* Devoted to the Arts and Sciences Related to the Silicate Industries

CONTENTS

Original Papers:

An Eighteen Months' High Temperature Test on Refractory Test Specimens—Riddle and Peck 1
Some Factors Involved in the Preheating of Glass Pots with Special Reference to Moisture Control—Oakley 23
A Deformation Study of Various Aluminosilicates and Borosilicates—Lu 29
Mineralogy of Clay—I—McDowell 55
Rational Analysis of Clay—II—McDowell 61

Ceramic Abstracts 1

The Bulletin:

Editorials 1
Papers and Discussions:
Statement on Behalf of Education Committee—McAfee 6
Opinions of Factory Man on Ceramic Education—Hill 7
Ceramic Education as Applied to the Refractories Industry—Booze 19
Extension Work in Ceramic Engineering—Watts 20
Should Product and Product Requirements be Stressed More in School Curricula?—Potts 24
American Ceramic Art Symposium 27
Ceramic Art and the Ceramic Artist—Curtis 42
American Ceramic Art for America—Weaver 45
Discussion on "An Electric Furnace for Softening Point Determinations"—Ross 47
Activities of the Society 49
Notes and News 84

Advertisers' Index 17

Plant where fat Minpro Spar is ground by the most modern equipment

MINPRO SPAR

Quality

The
ROESSLER & HASSLACHER CHEMICAL CO.
New York

Chicago
Boston
New Orleans
Cleveland
Trenton
Pittsburgh
Baltimore
San Francisco
Philadelphia
Kansas City

L&N AUTOMATIC
Potentiometer Pyrometers

Direct your firemen with signal lights at control points. Deviation Indicators show exact temperatures

For Facts as Applied to Kiln, Tank and Lehr Temperatures

Write for Catalog 87-K

Free on Request

LEEDS & NORTHRUP COMPANY
4901 STENTON AVENUE, PHILADELPHIA

LEEDS & NORTHRUP

Chicago, Ill. Los Angeles, Calif. San Francisco, Calif. Cleveland, Ohio

H F & G PRODUCTS ARE RELIABLE

CONTROL of all the processes in the manufacture of Ceramic chemicals by **H F & G** from the raw materials to the finished product insures uniformity of excellence.

The wide range of requirements and varied applications demand such control. Our years of experience, close study of physical and chemical properties, etc. is your insurance of quality.

Look for the well known **H F & G** mark.

THE HARSHAW FULLER AND GOODWIN CO.

Cleveland

Chicago New York Philadelphia

JOURNAL
OF THE
AMERICAN CERAMIC SOCIETY

A monthly Journal devoted to the arts and sciences related to the silicate industries.

Publication Office: 450 Ahnaip St., Menasha, Wis.
Editorial and Advertising Offices: Lord Hall, O. S. U., Columbus, Ohio.
Committee on Publications: F. K. PENCE, Chairman; W. E. DORNBACH, F. C. FLINT, M. L. HARTMANN, ROSS C. PURDY.
Editor: ROSS C. PURDY; Assistant Editor: EMILY C. VAN SCHOICK; Associate Editors: L. E. BARRINGER, E. W. TILLOTSON, ROY HORNING, R. R. DANIELSON, A. F. GREAVES-WALKER, F. H. RHEAD, H. RIES, R. L. CLARE

Application has been made for transfer of second class entry to the post office at Menasha, Wis.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 16, 1918.

(Copyright 1926, American Ceramic Society)
Twelve dollars a year Single numbers, one dollar
(Foreign postage, 50 cents additional)

Vol. 9 January, 1926 No. 1

ORIGINAL PAPERS

AN EIGHTEEN MONTHS' HIGH TEMPERATURE TEST ON REFRACTORY TEST SPECIMENS

FRANK H. RIDDLE[1] AND ALBERT B. PECK[1]

ABSTRACT

Advantage was taken of an eighteen months' continuous run of the Dressler kiln of the Champion Porcelain Company firing to cones between 17 and 18, to observe the effect of the temperatures and the gas conditions in various parts of the kiln upon a large number of standard bodies and experimental mixes.

The kiln and conditions within it are briefly described, as well as the types of bodies used.

The observed changes in outward physical properties of the bodies are supplemented by petrographic-microscopic examinations in order to determine or explain the reasons for the behavior of the bodies.

Three instances of the production of deposits of artificial minerals formed in the kiln during firing are also described and explanations for their occurrence are given.

Introduction

At the time the Dressler Kiln of the Champion Porcelain Company was shut down in June, 1924, it had been in continuous operation for a period of eighteen months in firing ware at cones 17 (1490°C) to 18 (1510°C) and occasionally even higher.

Before the kiln was lighted for this long run it was thought advisable to place a number of standard bodies and experimental mixes in various

[1] Research Laboratories, Champion Porcelain Company. Recd. October, 1925.

parts of the kiln with a view of observing the effects of various gas conditions as well as temperatures.

So far as the writers are aware, this is the first instance of experimental work being deliberately conducted under such conditions of long time at such high temperatures. The actual pyrometer temperatures to which the bodies were exposed cannot be definitely stated for the reason that the bodies were in the port holes, or behind or within the muffles, while the pyrometers were located along the crown of the kiln. The latter, however, showed a range from 579°C to 1462°C. The actual temperature of the bodies opposite a pyrometer was undoubtedly higher in all cases and in some instances much higher.

Even though actual temperatures cannot be stated definitely, the resulting effects on these experimental bodies were in some instances so interesting that it was thought they might also be of interest to others. It is the purpose of this paper at a later point to present results both from the standpoint of the physical and petrographic-microscopic changes involved.

The Kiln

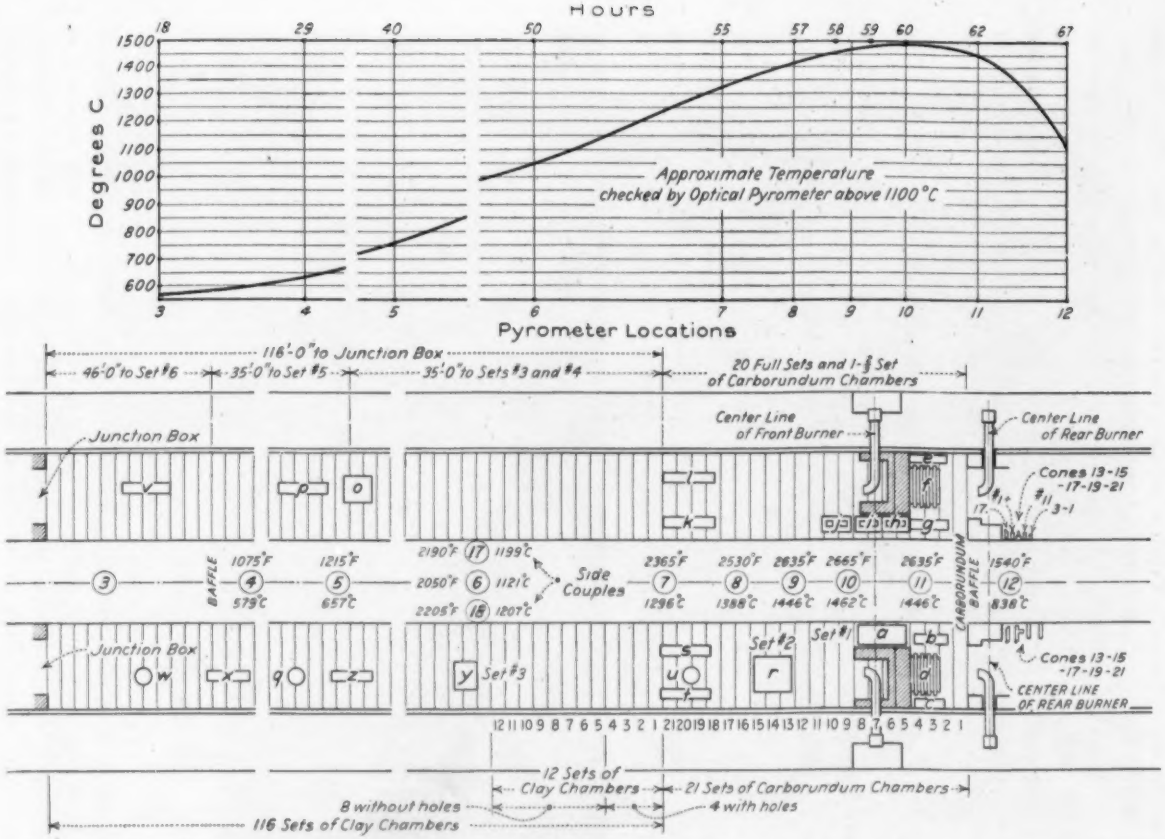
The Dressler kiln is, in general, similar in construction to the standard form of Dressler muffle kilns. On account of the extreme temperatures, great care was used in the selection of the refractories and the type of construction. Perhaps the two most unusual parts of the construction are the silica brick crown and silicon carbide brick damper boxes at the head end of the combustion chambers, through which the super-heated air is drawn down into the chambers for combustion.

The kiln, which is approximately 312 feet long, has combustion chambers approximately 140 feet from damper boxes to junction boxes where the products of combustion are drawn out to the stack.

Of the chambers, 21 sets or 21 feet are of very refractory high grade, shiplap-jointed silicon carbide, cemented together with a pure grade silicon carbide mixture containing a small amount of clay bond.

The silica brick crown extends for approximately 75 feet from the edge of the damper box along over the silicon-carbide chamber section. The balance of the crown is made of high grade clay brick.

Figure 1 shows a general layout and the positions of the various test specimens in the kiln. Unless otherwise mentioned, the only specimens of particular interest in the present case are those placed in the combustion chambers. The distance-temperature curve shown in Fig. 2 is the curve of the temperatures shown by thermocouples in the kiln crown. These would necessarily be somewhat lower than the combustion chamber temperature on account of the lag due to transfer of heat through the chambers. The gas analysis in the combustion chambers


Hours
18 29 40 50 55 57 58 59 60 62 67
Degrees C
1500 1400 1300 1200 1100 1000 900 800 700 600
Approximate Temperature
checked by Optical Pyrometer above 1100°C
3 4 5 6 7 8 9 10 11 12
Pyrometer Locations
116'-0" to Junction Box
46'-0" to Set #6
35'-0" to Set #5
35'-0" to Sets #3 and #4
20 Full Sets and 1-½ Set of Carborundum Chambers
Junction Box
Center Line of Front Burner
Center Line of Rear Burner
Cones 13-15 -17-19-21
#11 3-1
BAFFLE
1075°F 579°C
1215°F 657°C
2190°F 1199°C
2050°F 1121°C
2205°F 1207°C
Side Couples
2365°F 1296°C
2530°F 1388°C
2635°F 1446°C
2665°F 1462°C
2635°F 1446°C
CARBORUNDUM BAFFLE
1540°F 838°C
Junction Box
Set #3
Set #2
Set #1
Cones 13-15 -17-19-21
CENTER LINE OF REAR BURNER
12 11 10 9 8 7 6 5 4 3 2 1 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
12 Sets of Clay Chambers
21 Sets of Carborundum Chambers
8 without holes
4 with holes
116 Sets of Clay Chambers

FIGS. 1 and 2. Diagram of Dressler tunnel kiln showing the position of the various specimens and approximate temperatures indicated by the thermocouples in the crown.

may also vary considerably from the gas analysis in the ware firing tunnel. Substantially pure air is drawn down through the damper boxes from the ware tunnel. From a point where this unites with the fuel gas from the burners down through the combustion chambers to the junction boxes the atmosphere varies from slightly oxidizing or neutral at the burners to more oxidizing at the junction boxes. The chambers are, of course, under minus pressure. This is bound to result in some leakage of air into the chambers and thus brings about an increased oxidation as the gases progress down through the chambers.

Silicon-Carbide Cylinders and Sag-Bars

Test Specimens Silicon-carbide specimens were made up with a view of studying suitable mixtures for saggers for use in this particular factory. As a result the field was necessarily limited and hence may not be of general interest. A sagger for the work in question must show no signs of deformation at cone 20. The sagger walls are under compression while the bottoms have to withstand a sagging due to the load of ware. This puts the bottoms under a compression on the upper side and tension on the lower side. The

FIG. 3. Silicon-carbide cylinders at about 600°C. Note the amount of swelling and disintegration.

mixtures must also be fairly dry or free from fluxes which might tend to bore out and cause the ware being fired to stick. A dry mixture is more easily oxidized than one dense enough to have a glass-like surface, hence the desirability of studying this quality. Cylinders $1\frac{1}{2}$ inches in diameter by $1\frac{1}{2}$ inches high were selected for this test while bars 8 inches long, 2 inches wide and $\frac{1}{2}$ inch thick were selected for the sag test. These were supported on knife edges placed approximately six

inches apart. It was not necessary to place sag bars in any but the hottest parts of the kiln as sagging is only brought about by softening of

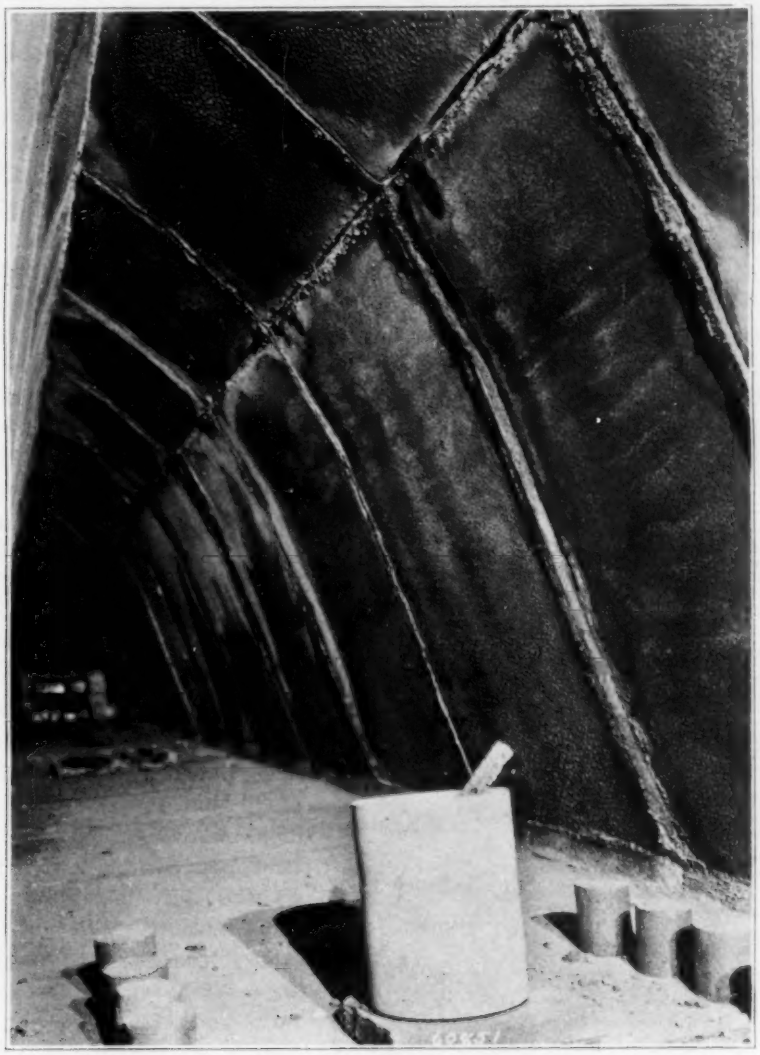


FIG. 4. Silicon-carbide cylinders at about 1200°C. Swelling and disintegration is not as marked as in Fig. 3.

the bond. These sagger mixtures depend on grain size for density and the denser ones are, of course, more difficult to oxidize than the more open-grained ones.

These silicon-carbide specimens proved to be among the most interesting of the test pieces taken from the kiln, covering as they did the whole range of temperatures existing in the kiln from a minimum of approximately 579°C to a maximum of above 1462°C.

Swelling and disintegration or dusting to degrees varying from partial to complete was a rather characteristic phenomenon. This was especially true at low to intermediate temperatures. At the higher temperatures it was not so prominent, although in some cases the specimens almost completely volatilized. Thus at the lower temperatures (about 600-1000°C) most of the specimens swelled to nearly twice their original size and dusted (Fig. 3). Some Fe_2O_3 gave a red or brown color to the specimens. At intermediate temperatures (about 1320°C) the bodies were firmer and also showed more or less Fe_2O_3 both externally and internally (Fig. 4). The outer surfaces presented a slightly glazed appearance. The interiors were always some shade of gray and the color was generally roughly proportional to the fineness of grain of the original silicon carbide. The lightest of all was a body which was composed entirely of new silicon carbide over half of which was finer than 65-mesh. At the highest temperature (1446°C+) the bodies were in front of the rear burner and in the muffles opposite the hot zone (Fig. 5). The temperature can only be indicated as above 1446°C. Swelling was not so apparent at this point but volatilization was very prominent. Two bodies containing 10% of clay had almost completely disappeared or changed to cristobalite. Many others showed only a hollow shell remaining.

FIG. 5. Silicon-carbide cylinders and sag-bars just in front of the forward burners. Temperature 1462°C+. The specimens have swelled and volatilized and are white due to a coating of cristobalite. Note the round craters or lithophysae both on the specimens and along the lower and upper joints of the muffles.

Petrographic examination showed several interesting facts and reasons for the behavior of the bodies. The most prominent new constituent formed was cristobalite. In low temperature specimens this occurred as minute grains or aggregates in which silicon carbide was embedded.

The cristobalite grains themselves very frequently showed numerous minute inclusions of bubbles. Although it cannot be definitely stated, it seems probable that these are CO_2 bubbles, the gas resulting from the oxidation of the silicon carbide having been entrapped when the cristobalite was formed as a result of the same action.

Specimens from points of intermediate temperatures showed the same sort of cristobalite. These specimens showed some vitrification due perhaps to both the higher temperature and the presence of a little Fe_2O_3. The light color of the interiors was due to the formation of cristobalite and the amount seemed to be governed by the amount of fine silicon carbide originally in the body. Fineness of grain appeared to encourage the formation of cristobalite.

In the high-temperature specimens, cristobalite was again very prominent, in fact, in some the amount of silicon carbide remaining was almost negligible. Usually the cristobalite was pure white and distinctly vitreous. Microscopically it showed much larger crystals of better development than in the lower temperature specimens. Gas inclusions were much less common at these temperatures, doubtless because so much cristobalite itself had been volatilized as well as CO_2.

Mullite ($3\ Al_2O_3.2\ SiO_2$) was found in varying amounts in nearly all specimens at all temperatures. In some its presence was due to the use of clay in the body. In others where no clay was used, it must have come in as an impurity.

The cause of the formation of the cristobalite in these cylinders must be due to oxidation of the silicon carbide since all the specimens were placed in the interior of the muffles where conditions were oxidizing at nearly all times. The completeness of decomposition of the silicon carbide was, as would be expected, proportional to the temperature to which it was exposed. The great swelling and disintegration of the cylinders at such low temperatures as 800°C or less was rather surprising. This in turn can be traced to the oxidation of silicon carbide to cristobalite, the presence of the latter being quite definite. In the high temperature specimens, however, much of the cristobalite was volatilized and carried away, but in the low temperature cylinders this was not possible. In the latter, therefore, the cristobalite accumulated, producing an increase in the original volume of the cylinders. This produced the disintegration and dusting, since the temperature was too low for sintering to take place. At intermediate and higher temperatures there was apparently sufficient vitrification with the formation of cristobalite on the outer surfaces as a protective coating to prevent much further oxidation and swelling. In some instances where cracks did form, oxidation and volatilization apparently penetrated along these

cracks, eating out the interior until only the outer shell of cristobalite remained.

In summary then, silicon carbide under oxidizing conditions seems to be sensitive to low as well as to high temperatures. Thus, long exposure in an oxidizing atmosphere at low or intermediate temperatures breaks it down more or less completely to cristobalite with consequent swelling and disintegration. It must be remembered, however, that the time factor here is large.

Spark Plug Bodies

It was natural of course that those carrying out these experiments should desire to know what might happen to a spark plug body upon exposure to different temperatures for such a long interval. To determine this, numerous spark plugs which had already received the usual firing were placed along the kiln. Some were placed in the interior of the silicon-carbide muffles but the majority were distributed among the port holes of the muffles from the cold zone to the hot zone. A few were placed along the forward part of the cooling end of the kiln but showed no changes. Petrographic examinations were made of all.

Behavior of the Glaze

In all specimens the glaze had been progressively absorbed into the body as the temperature increased. At the higher temperatures it is quite possible also that some of the glaze was volatilized. In either case as the glaze disappeared there was a crystalline growth of needle-like crystals of mullite. As a result of this the ware took on a dull appearance. These crystals of mullite are practically always present microscopically in even the clearest glaze of any porcelain body, especially at the junction of the body and glaze. The unusual growth of crystals here appears to be the result of favorable conditions of time and temperature and concentration of the crystalline portion of the glaze by the removal of the excess glassy matrix. Thus the bodies appear to have a crystalline glaze.

Effect on Crystalline Development in the Body

The average once-fired body shows a high percentage of minute, roughly rectangular crystals of mullite with square cross sections, embedded in a glassy matrix (Fig. 6). These are generally about twice as long as they are wide and in actual size measure about 0.0001 to 0.0002 in length by 0.00005 to 0.0001 inch in width.

At temperatures of 1200°C and lower there seems to have been little effect on the body in increasing the size of the original crystals. At no time did they become essentially larger or show a better development than the average once-fired body. At 1296°C, however, there

was a distinct increase in the size of the crystals and a definite sharply angular development. At this temperature they averaged twice the size of those of the usual once-fired body. At a temperature of 1462°C their average size was from four to five times as great and the sharpness of crystal outline was also very marked.

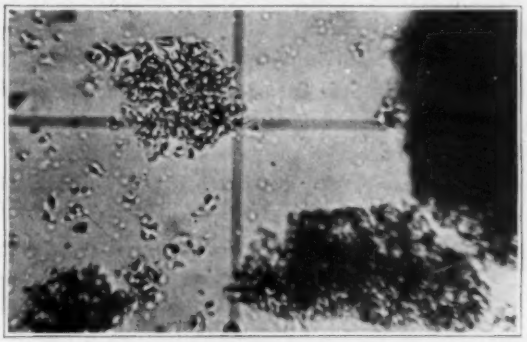


FIG. 6. Photomicrograph of fragments showing the development of mullite crystals in a regular one-burn spark plug body. Magnification 525 times.

One group of bodies is especially worthy of mention because they were placed just in front of the rear burner of the hot zone. It is impossible to state the temperature except that it must have been far above 1462°C, the temperature of the kiln in the hot zone. Both the surfaces and cross-sections of the bodies showed a distinctly crystalline nature and in some places needle-like crystals up to $\frac{1}{16}$ to $\frac{3}{32}$ inch in length were observed. These bodies showed a very white color on the tips and had become distinctly translucent. This was due, as microscopic examination showed, to the unusually large crystals developed (Fig. 7). Microscopically, the mullite crystals were unusually large and perfectly formed. It was difficult to find a fragment showing the complete length of a large crystal but crystals with cross-sections of 0.0015 inch were common. Judging from the size of the cross-section, the length of such crystals might easily reach 0.01 to 0.03 inch. In view of this, the translucency of these plugs is easy of explanation because the innumerable small crystals of the originally rather opaque body have coalesced to form a comparatively few large crystals with resultant loss in light-scattering power.

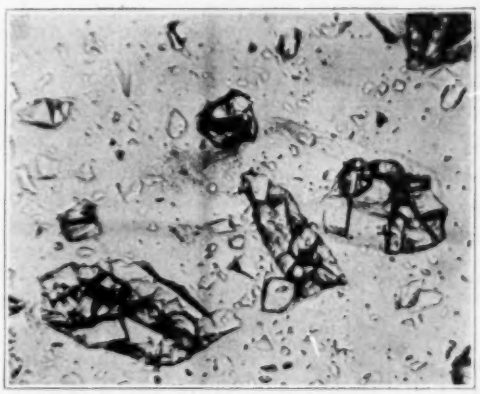


FIG. 7. The same body as in Fig. 6 from in front of the forward burners. Temperature 1462°C+. Magnification 150 times.

Thus, this spark plug body appears to be remarkably resistant, up to 1200°, to further increase in the size of crystals developed and although they do enlarge above this temperature, the increase is relatively small when the time through which they were exposed to these temperatures is considered.

It should also be noted that at no temperature did any of the bodies show the least indication of deformation. Those exposed to the highest temperature directly in front of the burners were mounted vertically. The bases of these plugs stood on silicon carbide. This had gradually volatilized with the result that the bases of the plugs were dark colored probably due to the absorption of carbon or silicon carbide itself.

Absence of Corundum

It is a fact worthy of mention here that even at the highest temperatures to which these bodies were exposed there was no essential change in the crystalline constituents. At no point did corundum appear. The highest temperature even though not known definitely (simply above 1462°C) was well below the temperature (1810°C) designated by Bowen and Greig[1] at which corundum forms in pure Al_2O_3-SiO_2 mixtures but the presence of fluxes such as are present in these bodies might easily have lowered the temperature for the formation of corundum, similarly as it may be found near the walls of soda-lime glass tanks.

Pyrometer Tubes

The pyrometer protection tube specimens were sections of tubes and represent two or three manufacturers' products as well as some vitreous mullite tubes fired at cone 32. The photographs show considerable differences in the quality. Unfortunately these tubes could not be suspended and hence were more or less affected by the refractories on which they were placed as well as fluxes deposited from dust drawn in with the gas and air. However, portions were free enough from contamination to allow much valuable information to be obtained from a study of them. It is evident that gas tightness and long life are largely affected by the silica-alumina ratio and character and amount of fluxes present.

In many instances the pyrometer tubes occupied the same positions as the spark plug bodies and silicon-carbide cylinders. Most of these bodies were unglazed and hence could not be compared to the spark plug bodies in that respect. One body had crazed badly and was very brittle at intermediate temperatures. It was a general observation in this range of temperature that long continued heating tended to make most of the tubes more brittle than they were originally, some more noticeably so than others. The fractures also varied; some were smooth, others rough and pimply.

[1] *Jour. Amer. Ceram. Soc.*, **7**, [4], 238-54 (1924).

Tubes exposed to temperatures of about 838°C and less showed no change in micro-structure from the original tubes. The constitution of the original tubes is in general quite similar to that of spark plug bodies, namely, numerous small crystals of mullite in a glassy matrix.

One set of tubes exposed to a temperature which was probably about 1050°C was accompanied by a number of widely differing Orton cones. Of these cone 4 was flat. From this we would infer either that there was a sudden increase in temperature at some time or else that owing to the time element involved the cone had fused at a temperature about 150°C or more below its theoretical point. Of the two the latter seems more likely.

These tubes with one exception showed a smooth fracture. There was one noticeable exception to this, which showed a rough fraction and was very brittle. The same resistance toward change in crystalline development was apparent here as in the spark plug bodies. There was no marked change in the size of the crystals, their development being only a trifle sharper (Fig. 8).

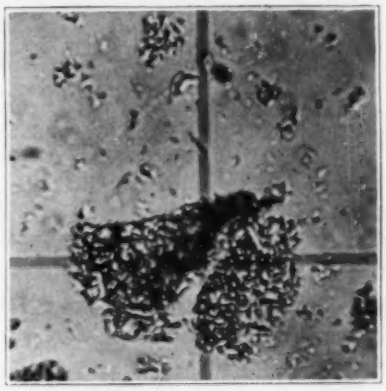


FIG. 8. Photomicrograph of a pyrometer tube body showing the size of the mullite crystals. Temperature about 1050°C. Magnification 525 times.

Another set of tubes exposed to a temperature of about 1200°C showed cone 13 fused. Here again the actual temperature was well below that of the indicated cone temperature. Some of these bodies had a smooth fracture, others were rough and brittle. On some of the latter the fracture surfaces showed numerous white, pimply areas and the whole body was badly crazed. The size of the crystals in these bodies was not noticeably greater than in a once-fired body (Fig. 9). It does not seem possible therefore that the brittleness, roughness of fracture, and crazing can be due to any unusual crystal growth, since the crystals did not vary from those of satisfactory bodies. It seems probable that these qualities are connected with the chemical composition of the body and possibly also may be due to gases present and the state of oxidation or reduction of the kiln.

At a temperature of 1446°C+ with cone 30 flat and cone 32 slightly tipped, all bodies with the exception of the one once mentioned previously showed a smooth vitreous fracture. The exception, although smooth in fracture, was badly blistered and full of holes. As might be

expected, these bodies distinctly showed the effect of the high temperature. The mullite crystals averaged from four to six times the size of those of a once-fired body (Fig. 10). In the blistered body the crystals were especially large and perfectly developed and glass was quite abundant. This might be taken to indicate the presence of more flux than in the other bodies, which in turn might easily lead to blistering.

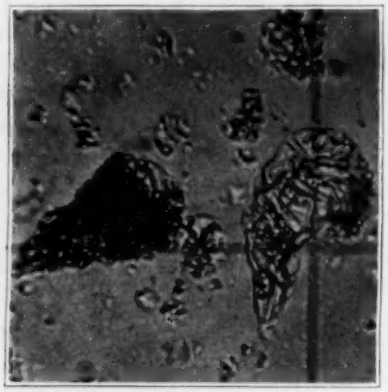


FIG. 9. Pyrometer tube body at about 1200°C. Note that the mullite crystals are only slightly larger at this temperature. Magnification 525 times.

Finally, a group of bodies just in front of the rear burner where the temperature was far above 1462°C was very crystalline in nature. Crystals as large as 0.08 inch were visible. All the bodies had a smooth crystalline fracture and were fairly tough. All showed distinct flattening from the effect of flow under the extreme heat to which they were subjected. As in the case of the spark plug bodies from the same position, the crystals of mullite were very large (Figs. 11 and 12). Rounded ends were quite noticeable, possibly indicating a temperature near that at which they might break down into corundum and

FIG. 10. Pyrometer tube body at about 1446°C. The crystals have grown much larger but not as large as might be expected. Magnification 525 times.

FIG. 11. Pyrometer tube body from in front of the forward burners. Temperature 1462° C+. Note the increased size of the crystals at a magnification of 150 times, slightly more than ½ that of Fig. 10.

liquid. No corundum could be observed, however. The whole group of bodies showed the effect of the greater heat. The greater toughness of this group seems to indicate that the increased temperature has had a beneficial annealing or similar effect as compared to those at 1200°C.

These pyrometer tube bodies can only be roughly compared to the spark plug bodies. Both physically and microscopically most of the compositions appear to be less refractory than the spark plug bodies. Neither do the latter show the blistering, crazing, or rough fracture effect of the pyrometer tubes, and thus are more stable.

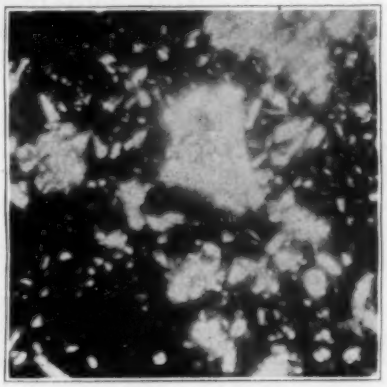


FIG. 12. Same field as Fig. 11 taken between crossed nicols. The bright, strong double refraction shown by the crystals gives some idea of their size and thickness.

Silica Brick

While other samples were being taken it was thought advisable to make brief note of the changes which had taken place in silica brick from the hot zone. For this purpose three samples were taken which served to give both a horizontal and vertical cross-section of the zone. The three samples showed well the variation in temperature through the hot zone.

The first sample was from the bench at the beginning of the zone. Externally it was white but beneath the surface it showed an appearance rather like that of a stock brick. The temperature at this point was approximately 1300°C. Microscopically it showed a low quartz and fairly high tridymite content with much cristobalite exhibiting no definite crystallization. The amount of quartz was not over 10% and probably was much higher in the original brick with correspondingly less cristobalite and tridymite. The facts that tridymite does not predominate now, that the crystals are not especially well developed, and that the quartz is very low, would seem to indicate that the temperature was usually above the tridymite-cristobalite inversion point. This does not necessarily mean that the temperature was above 1470°C, because the small amount of flux present in the brick might lower the inversion point noticeably.

The other two bricks were taken from the hottest part of the kiln, one from the bench and the other directly above, from the center of the crown. They show in their microstructure not only that the temperature was higher than the point where the first brick was located but also

that the temperature varied vertically as well. The brick from the crown showed much larger crystals of cristobalite and also a much more vitreous character than that from the bench below, indicating directly a definitely higher temperature. The presence of no other form of silica than cristobalite except a very few tridymite crystals shows that the temperature of both bricks was practically continuously above the cristobalite-tridymite inversion point.

The brick from the crown was very porous and vitreous in character and the mortar had disappeared to a considerable extent. This leads to the possibility that some of the fluffy silica glass found in the cooler portions of the kiln may have been due in part to the volatilization from the silica crown.

Owing to the fact that the crown was not dismantled it was impossible to trace the effect of the heat upon the brick from the inner to the outer side of the crown.

Bonding Materials

A number of bonding materials were tried out through the hot zone. Generally they were used to cement 2-inch cubes of other material, which were placed in the lower port-holes of the silicon-carbide chambers. Three general types of bonds were used, siliceous, fire-clay, and chromium. All were subjected to temperatures of about 1460°C.

The siliceous bonds generally had formed cristobalite with a little tridymite. Usually some glass and mullite crystals were present probably having been derived from a small amount of clay binder.

The fire-clay bonds had generally formed considerable amounts of glass in which were numerous crystals of mullite. In several instances the glass had been absorbed into the brick or had flowed away leaving very little bonding material. In some instances almost the only remaining product was needle-like crystals of mullite sometimes reaching $\frac{1}{8}$ inch in length. These were usually covered with a thin coating of glass.

The chromium bond also had decomposed to form a glass containing mullite crystals and in most cases had flowed away from the joints. It was rather surprising upon breaking apart two of the bricks to find some grayish metallic matter with yellow and blue tarnish colors. This was not analyzed but one would suspect that some chromium had been reduced.

Of the three types of bonds, those of highly siliceous nature stood up best. They had swelled slightly, as could be seen from the manner in which the bond bulged out beyond the surface of the brick at the joint, due to the formation of tridymite and cristobalite. Although resistant to fusion they had but little bonding power and could be expected to do nothing more than fill the joint.

The fire-clay and chromium bonds formed too much glass to prove satisfactory at these temperatures.

Mortar for Silicon Carbide

It may be of interest to call attention here to the behavior of the mortar used in setting the silicon-carbide chambers. This was composed of silicon carbide and clay. When the kiln was finally opened it was found that the mortar had swelled very noticeably and as a result had squeezed out from the joints. The net result was to form an exceedingly tight joint between the chambers. The cause of this might be due in part to the natural expansion of the chambers but undoubtedly the major cause was that revealed upon microscopic examination.

This examination showed a very large amount of granular cristobalite with silicon carbide, mullite, and some glass. The cristobalite had apparently formed from the oxidation of the silicon carbide and because of the siliceous character of the product it had been able to counteract any tendency of the fluxing action of the glass formed from the decomposition of the clay. Thus, not only was a very refractory bond formed but also one which made very tight joints. It was rather fragile and did not have much bonding power, its value being in the other directions mentioned.

Incidental Products Noted

Silica Glass It is a curious fact that this was noted in several places along the cooler portions of the kiln but not in the hotter zones. It took on two distinct forms. One was in the form of a white coating, extremely light and fluffy in character, with a smooth outer surface resembling that of a mushroom. It coated the clay chambers and also the ports of the chambers to varying thicknesses which sometimes reached a depth of one inch. It was especially thick and abundant along the upper edges of the chambers and the higher port-holes (Fig. 13). A partial analysis showed variations from 97.32 to 98.42% SiO_2, the remainder being largely Al_2O_3 and Fe_2O_3.

A second type was fibrous in character and was built up and bent around corners in such a manner as to indicate the direction of the convection currents of the kiln gases. It seemed to be confined entirely to the lower port-holes in the clay chambers and was not nearly as extensive in range or amount as the first type.

The way in which these deposits of silica were distributed through the kiln presented rather interesting questions. First, the distribution of the deposits along the walls was not even. While one side of the kiln

might show considerable amounts of the deposit, the opposite wall might be free or nearly free from it. Also, where it might be present largely on the upper edge on one side, the reverse might be true on the opposite side. The smooth-surfaced type might be opposite to the twisted, fibrous type. Furthermore, there were considerable breaks in the distribution of the deposits along the kiln. Areas of abundant

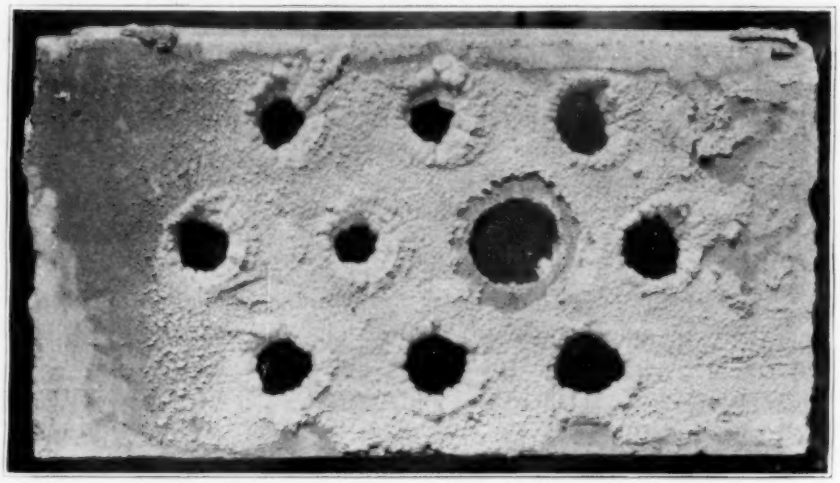


FIG. 13. Mushroom-like deposits of silica glass formed in the water-smoking zone. One port hole has been cleared away to show how the material nearly filled the openings.

deposits would cease abruptly only to reappear again farther on toward the hot zone. Why these phenomena should occur with such irregularities is rather puzzling and it may suggest that we do not know quite as much concerning the kiln gases and their circulation as we think, and that we still have something to learn concerning this.

The source of this deposit of silica is another interesting question. There appear to be two or three possible sources. The first is that under the influence of water-smoking of the ware some silica was volatilized. This does not appear likely owing to the comparatively low temperatures involved. Yet one must remember that highly heated water vapor has a very pronounced solvent power, but this is more particularly true under conditions of high pressure not present in this case. A second possible source is the silica brick crown of the hot zone from which silica may have been volatilized and carried to the cooler portions of the kiln for deposition. The silica brick were somewhat porous where exposed in the crown but sufficient volatilization does not appear to have taken place to warrant it having been the source of all the silica

deposit. The third possible source is the silicon-carbide muffles of the hot zone. These had been oxidized to varying degrees especially in the vicinity of the forward burners. The temperatures here were, of course, very high and in an oxidizing atmosphere silicon carbide decomposes, one of the products being gaseous SiO_2. Thus, if SiO_2 gas from the hot zone was carried to the water-smoking area, ideal conditions would be present for the powerfully oxidizing water vapor to complete the oxidation to SiO_2 and also suddenly cool the SiO_2 vapors with consequent deposition of silica glass. If conditions in the hot zone were only intermittently oxidizing, deposition would also be intermittent.

Incidentally similar light, fluffy deposits may be observed in the hood of an arc light where the silica has been volatilized from the clay binder of the carbons in the presence of air and deposited on the cool hood.

Magnetite (Fe_3O_4)-Hematite (Fe_2O_3) Deposits

These were found at the beginning of the cooling zone, coating the lining of the intake of the damper box as well as various test specimens which had been placed there. They sometimes formed a thin coating of minute, black, glistening, closely crowded crystals while at other points they projected from the surfaces of objects in branching arborescent forms (Fig. 14). In a few cases where they had formed on glazed objects, such as spark plugs, fusion with the glaze had taken place and a black discoloration resulted.

FIG. 14. Some isolated groups of arborescent magnetite-hematite deposits. Magnification 40 times.

The crystals were formed at atmospheric pressure or greater and under fully oxidizing conditions, since the air used for cooling the ware was fresh air which was drawn from the outside at the exit end and forced into the kiln toward the hot zone.

Some of the masses of crystals showed magnetism while others failed to show it. Microscopic examination showed the crystals to be composed of both hematite and magnetite.

Hostetter and Sosman[1] have shown that Fe_2O_3 dissociates with measurable pressures at 1100°C into Fe_3O_4 and free oxygen, and that the dissociation undoubtedly begins at a lower temperature, perhaps

[1] *Jour. Amer. Chem. Soc.*, **38**, 1188-98 (1916).

1000°C, and increases with higher temperatures. The presence of hematite (Fe_2O_3) therefore would indicate a temperature of formation of less than 1000°C. But in this case the form of the crystals indicated that of the octahedron, for although exact measurements of the crystals were precluded owing to their poor development, a low magnification showed them to be eight-faced, with the long axis a tetragonal axis. This corresponds to the form in which magnetite commonly crystallizes whereas hematite crystallizes in hexagonal forms. It is apparent then that the crystals originally formed as magnetite (Fe_3O_4) and as such should have formed at a temperature above 1000°C. Thus, it would appear that the temperature of the kiln in this vicinity never dropped below 1000°C for any considerable period of time. How much higher the temperature might have been, cannot be told accurately but a series of cones from 13 to 26 placed in the intake and upon which crystals had formed, showed no indications of fusion. The limits of the temperature then would be below a theoretical 1390°C and, according to Hostetter and Sosman, above 1000°C, in all probability very much closer to 1000°C. However, thermocouple No. 12 in the crown nearly opposite the intake registered a temperature of near 840°C. This points to the conclusion that under the condition of prolonged heating as was present in this case, the temperature of dissociation is very probably much lower than indicated by the work of Hostetter and Sosman, perhaps as low at 850°C.

According to Sosman,[1] the dissociation temperature of Fe_2O_3 at atmospheric pressure cannot be lowered unless solid solution of Fe_3O_4 in Fe_2O_3 takes place, a point not yet definitely proved. Since the facts of the present instance point toward the dissociation temperature being lower than previously supposed, the possibilities of solid solution having taken place are somewhat more certain than formerly indicated. We are not prepared at present to make a definite statement in regard to this but we hope to have analyses of crystals from different points in the kiln available in the near future, which will show whether there is any variation in the FeO content.

The presence of Fe_2O_3 in these crystals can be accounted for by the fact that as the kiln cooled below the dissociation point, oxygen was absorbed from the air by the Fe_3O_4 until Fe_2O_3 resulted. Thus there was formed what is known in mineralogical terms as a pseudomorph (false form) of hematite after magnetite, the crystal form being that of the magnetite originally formed while the chemical composition is more or less that of hematite.

The source of the iron which formed these crystals would seem to be derived from the wheels and frame of the cars carrying the ware and

[1] Private communication.

in part also from the water-cooling pipes along the floor of the kiln in this zone. The fresh air introduced to cool the ware might easily oxidize the hot iron parts of the car and carry the resulting iron oxide vapors along to be deposited in the damper boxes. Any moisture in the air would increase the oxidation markedly.

Cristobalite Lithophysae

On many of the silicon carbide specimens which were in front of the forward burner of the hot zone, white, shell-like, crater formations up to an inch in diameter were observed (Figs. 5 and 15). These bear a very striking similarity to the cavities known as lithophysae (stone bubbles), found in certain types of igneous rocks. The craters formed on the silicon carbide usually possessed only a single rim and because of this were not quite so perfectly developed as those found in rocks. Natural lithophysae are

FIG. 15. A close view of a row of lithophysae formed along a joint in the silicon-carbide muffles. See also Fig. 5.

usually made up of a series of concentric rings or rims of rock so that the result is in appearance similar to that of a flower with its concentric layers of petals. The cristobalite lithophysae, although mainly showing only a single shell, do show by the presence of fine horizontal grooves on the outer side of the craters that they have been built up discontinuously.

As has already been indicated these craters were built up of cristobalite which could be seen microscopically to be composed of irregular grains or cubical or skeletal crystals. Outwardly, the craters are pure white in color, quite smooth, and vitreous.

The lithophysae in rocks are supposed to result from dissolved gases in the molten rock magma breaking through the viscous mass which immediately afterward solidified. The phenomenon may closely resemble that which takes place when a thick pudding boils except that the cavity does not close after the escape of the gas. Possibly, also, the lithophysae in rocks have been formed by the deposition of material from circulating gases in the cooling mass. The craters formed on the

silicon carbide were probably built up by the deposition of material at irregular intervals. No doubt the intense heat from the burners decomposed the silicon carbide and SiO or SiO_2 gas formed. As the gas escaped from the body and came into contact with the oxidizing atmosphere at the surface, SiO_2 would be formed and deposited as cristobalite. The chambers being under a minus pressure also drew some gases through small leaks in the joints of the chambers and built up craters of cristobalite at those points. If conditions varied to other than oxidizing, deposition would stop and with a change again to an oxidizing atmosphere it might be resumed with upbuilding of the crater. Thus, we can account for the irregularity of deposition as shown by the horizontal rings on the shells.

Summary

Under oxidizing conditions where the time factor is great, silicon carbide appears to be sensitive to temperatures as low as 600°C, as well as at extremely high temperatures. At the lower temperatures, oxidation to cristobalite is accompanied by great expansion. At high temperatures, expansion is not so pronounced but volatilization is very great.

The spark plug bodies used, proved to be very resistant to changes in microstructure up to 1200°C. The increase in the size of the mullite crystals above this temperature is relatively small, temperatures considered. No corundum was developed in the bodies at even the highest temperature to which they were exposed nor were any signs of deformation apparent, although at high temperatures the glaze had usually been absorbed or volatilized.

Pyrometer tubes showed the same crystalline components as spark plug bodies but not the same resistance toward increased size of crystals with temperature. The refractoriness was less and the tendency toward blistering and crazing was greater in the pyrometer tubes.

Silica brick from the hot zone showed variations in microstructure (both horizontally and vertically) in accord with temperature conditions prevailing.

Siliceous bonding materials stood up far better than fire-clay or chromium bonds. A silicon-carbide mortar used for the silicon-carbide chambers in the hot zone showed oxidation to cristobalite with consequent swelling which resulted in a very tight joint.

Three incidentally formed artificial minerals were found. Silica glass, occurring in the water-smoking zone, was probably derived from volatilization of silicon carbide and silica brick in the hot zone with precipitation of silica glass when the SiO_2 gases came in contact with the steam in the water-smoking area. Crystals composed of a mixture

of Fe_3O_4 and Fe_2O_3 were found in the cooling zone under conditions of temperature, pressure, and oxidation that point to a possibility of the dissociation temperature of Fe_2O_3 being lower than previously supposed. On many specimens of silicon carbide within the muffles of the hot zone lithophysae composed of cristobalite had been formed through oxidation of silicon carbide.

Discussion

C. F. GEIGER: The combustion chambers used in the Dressler tunnel kiln in which these tests were run were commercially manufactured silicon-carbide refractories and the photographs show no evidence of any such oxidation of these chambers as Dr. Peck found with his laboratory test samples of bonded silicon carbide grain.

We believe that these combustion chambers are considered quite satisfactory for this kiln and it must be admitted that there necessarily is a vast difference in quality between Dr. Peck's test samples and these chambers which have been in service a longer period than the eighteen months during which they were exposed to exactly the same conditions as the samples.

A. B. PECK: Everybody realizes that under oxidizing conditions you cannot expect that material to stand up. I do not think ordinarily we expected it to stand up, but, it is rather interesting from the scientific standpoint that you had that oxidation at the extremely low temperature.

T. CHRISTIAN: I have had a little experience with silicon carbide and the results almost parallel these conditions, but, the time factor is very different. I made up some silicon-carbide crucibles, some with clay and some with organic bond. I then placed them in a furnace and held them to about cone 34 for an hour. The results were very similar to the silicon-carbide cylinders spoken of in the high heat zone.

C. F. GEIGER: It is quite evident that the samples Dr. Peck and Mr. Christian have used are not at all representative of silicon-carbide refractories found on the market, and that they certainly are not properly bonded and fired or else they would not have oxidized in the manner or to the degree that they did.

There are many factors governing the development of silicon-carbide refractories and if grit sizes, nature of bond, and a number of other variables are not properly controlled it is very easy to produce a silicon-carbide refractory much inferior to even a poor fire-clay brick.

All varieties of silicon-carbide refractories are not equally good or equally bad. This is the case also with other specialized refractories.

Merely because we start with a valuable refractory material, whether it be silicon carbide, electrically fused alumina, or periclase, for example, it does not necessarily follow that all attempts to bond and fire any of these materials will result in a highly satisfactory finished product, for there is much to be learned about the manufacture of any of these.

Mr. Hudson stated[1] in his discussion of the paper by M. L. Hartmann and O. B. Westmont that he had found that electrically fused alumina refractories were only 12 to 15% poorer heat conductors than silicon-carbide refractories. Mr. Westmont replied that he found that the heat conductivity ratios were more nearly 4 to 1 in favor of silicon-carbide refractories. I am quite sure that these two men did not use the same kind of silicon-carbide brick in their comparative tests. This again shows that very widely different results can be obtained from bonded refractories which are substantially alike in their chief ingredients.

ROBERT TWELLS, JR.: I do not wish to apologize for these specimens because we were working with a different aim in view than Mr. Geiger has in mind. We are not trying to make chambers for the kilns. We are trying to develop high grade silicon-carbide saggers that could be used in our plants and we are experimenting with mixtures, or rather the conditions under which these mixtures oxidize. We are trying to find out whether or not the denser mixtures oxidize more easily, and things of that nature, although most of those things we could determine theoretically. The fact remains that saggers made from some of these mixtures have met our service conditions much better than other mixes which might appear to some observers to be superior.

[1] *Jour. Amer. Ceram. Soc.*, **8**, [5], 286 (1925).

SOME FACTORS INVOLVED IN THE PREHEATING OF GLASS POTS WITH SPECIAL REFERENCE TO MOISTURE CONTROL[1]

By W. W. Oakley

ABSTRACT

The moisture content of the atmosphere of a pot arch preheating covered pots is a very important factor. Heating in a humid atmosphere tends to equalize the rate of removal of moisture from the inside and the outside surface of the pot at temperatures above 212°, decreasing mechanical strains set up in this process.

Owing to the severity of service on glass melting pots, failure often occurs for no evident reason. Much has been written on the importance of the preheating process as to its effect on pot life and many designs of pot arches have been proposed tending to equalize the rate of preheating at all parts of the pot, but these proposed designs have seldom been built, owing to construction difficulties and costs. Owing to the fact that good results could be obtained with rather crude types of arches under properly adjusted conditions, it has become more or less prevalent to entrust the preheating of the pots to one man who has developed his own methods for the delivery of a hot pot without any visible checks to the pot-setting gang. Furthermore, if checks were not visible, the only test for the soundness of the pot was to tap it with a rod to see if it would "ring" true.

This paper is written with the idea of calling attention to some of the difficulties involved in the technical control of the operations involved in preheating pots with the hope that it may help the glass manufacturer in clearing up some things difficult to understand. There are three considerations involved in preheating pots: (1) requirements, (2) the apparatus used, (3) methods. A pot may vary in thickness from possibly six inches at the bottom to as little as two inches at the crown. It may weigh 3000 lbs. It is delivered to the preheating arch which may be at a temperature of anywhere below 130°F. This temperature may not be a desirable condition but it is often a fact. The pot is a covered, hollow object, dried on the outside faster than on the inside, as the inside humidity while drying will be at least 10% more than the outside, regardless of all efforts to equalize it. Under these conditions the outside is certain to dry faster, resulting in a side wall strain.

When the pot is arched it will contain at least 1½% mechanically retained moisture. The combined moisture will vary with the composition. In addition to the drying strains, the pot may have strains set up by rough handling.

[1] Received in revised form October 28, 1925.

There are four fuels which are used for heating arches:

(1) **Coal** The use of coal is attended with a great probability of temperature fluctuations due to firing methods and especially fire cleaning. Much of this variation can be minimized by constructing the arch with more than one firebox, which, however, entails further expense and, likewise, is often somewhat difficult to accomplish where small arches are badly crowded. Furthermore, the purchase of coal with existing markets results in a tendency on the part of the management to change grades, and this in turn tends to perplex the firemen.

(2) **Natural Gas** This is the ideal fuel for this purpose. It is to be remembered, however, that unless comparatively large piping is used and a good pressure maintained the adjustment on one arch may affect the adjustment on another.

(3) **Oil** Oil is subject to difficulty with the burners at low temperatures. This makes it difficult to secure a uniformly rising temperature. Furthermore, with arches built more or less in the open, trouble is experienced with frozen air lines and sluggish oil in cold weather. Also, at high temperatures it is especially severe on the firebox.

(4) **Producer Gas** When used in the raw, hot condition it is difficult to secure a satisfactory temperature gradient using this fuel at low temperatures, owing to the size of the valves necessary for eliminating soot trouble. The gas supply is subject to firing conditions and the building up of troublesome soot deposits. Furthermore, the cost of equipment is expensive and considerable space is required. Where there are more than two arches the adjustments of one will seriously affect the adjustments on the other, so that the use of this fuel requires considerable attention.

The empiric practice developed for preheating pots differs decidedly from that used in firing solid clay objects such as tank blocks. The problem of firing blocks is one of driving out the moisture at a rate slow enough to avoid checking and then removing this moisture from the arch or kiln as rapidly as possible by admitting sufficient air to pick it up and carry it up the stack. The admission of this air tends to even up temperature conditions so that the use of a draft gage and a good temperature measuring installation will closely indicate the uniformity of firing results. Furthermore, checks in a tank block do not necessarily affect the life of the tank, whereas checks in a pot cause premature failure.

In heating a closed pot in an arch the inside surface of the pot is heated almost entirely by conduction from the outside. Unless care is used, the portion of the pot nearest the firebox will be heated much faster than either the inside surface or the outside surface farthest from

the firebox. The only way to increase the rate of heating on the cool side of the arch is to use enough excess air to equalize it. This in turn tends to heat the outside surface much faster than the inside, thereby setting up strains in addition to those produced in drying. It was found out very early apparently that this excess air would cause checks and hence the practice developed by which the flues were kept closed absolutely tight as long as possible. While this heated the pot unevenly, the checks ceased. This practice naturally resulted in a very smoky fire being used at low temperatures and was only justifiable from a fuel viewpoint on account of the results obtained. Air leaks were carefully stopped, regardless of the relative pressure inside and outside the arch. Arches were located where there would be a minimum of wind. The soot covering the pot supposedly protected it and when the temperature could no longer be increased, the damper would be opened. This would immediately cause a complete change in the temperature distribution in the arch.

Furthermore, this practice occasionally caused unexpected results. A damper might break. Two arches on the same stack might affect each other or the amount of air drawn into the arch under these conditions, being dependent on leakage, might vary considerably. To overcome some of these problems, temperature measuring and draft recording apparatus were used and a close control at low temperature demanded. For the first day a temperature increase of 3° C per hour may be scheduled. This, however, involves difficulties. First, with the more or less standard method of handling the arch adjustment, the top of the arch is hot when the bottom is cold. The only method by which anything can be determined as to bottom conditions is by the installation of a bottom element. As arches run at temperatures under which base metal couples will not operate, a platinum couple is required for this service and a couple long enough for bottom control is very expensive. Likewise, its installation is difficult and always subject to serious damage in removing the pot. Pyrometric cones used on the bottom simply indicate the maximum temperature reached. Even though the outside of the pot is of uniform temperature, there still exists the question of lag in temperature on the inside.

In considering the above factors it is quite apparent that even when temperature schedules are worked out correctly and used carefully, the only point in the pot that will be fired according to schedule is that nearest the element. Under these conditions it is entirely possible to add sufficient fuel to keep the element on schedule, the balance of the heat being pulled downward by the draft, causing a rapid increase in temperature of the bottom of the pot. This can be minimized to a certain extent by stopping the temperature increase at the time the

damper is opened, allowing the bottom of the pot an interval to heat to a point nearer the top. In spite of this, however, it is apparent that severe, uncontrolled temperature shocks occur even when the elements read correctly.

In view of the work done in emphasizing the value of humidity control in drying, the extension of the same principles in the firing apparatus might be used to minimize the strains set up at the early stages. In considering this question an analysis of the conditions brought out the following fairly consistent facts:

(1) All fuels except possibly anthracite coal contain large amounts of hydrogen which upon burning results in a flue gas containing moisture. In all considerations of flue gases when tests are made by chemical methods, the moisture disappears in the apparatus, causing its effect to be lost sight of. The moisture content of the flue gases from common fuels is shown in Table I.

TABLE I

Fuel	Cu. Ft. Water Vapor per 1000 B.t.u. Liberated.	Percentage Water Vapor by Volume in Flue Gases.
Dry Pittsburgh coal	.0639	4.09
Dry hot producer gas	1.5	10.3
Fuel oil	1.362	12.48
Natural gas	1.92	17.5

It is to be observed that the combustion of natural gas gives the wettest flue gas. Producer gas gives the driest.

(2) Pots do not check as easily when heated with oil as when heated with producer gas.

(3) Men of long experience know that it is easiest to get good pots from the arches during the latter part of summer when the air carries most moisture. This was ascribed to weather conditions, there being less wind at this time.

(4) The deposition of soot on the pots indicates insufficient air. As the moisture content of the air admitted is lower than that which exists in an arch firing a clay object, this soot indicates that a maximum amount of moisture exists in the arch. The experienced operator does his best to maintain this soot.

(5) The sealing of the damper conserves the moisture driven out from the pot, increasing the moisture content of the arch atmosphere.

(6) The experienced operator will go to extreme measures to stop drafts around the back of his arches in the winter when it is dry even though this air cannot possibly get into the firebox except through controlled openings.

(7) In studying temperature conditions large amounts of heavy-

unfired blocks were placed in back of the pots in order to protect them and again good results occurred. These blocks would naturally tend to increase the moisture content.

(8) Pots in the front of arches often appear to be better than those in back.

(9) Finally during 1919 and 1920 owing to production conditions we were compelled to heat up a furnace immediately after a clay siege was built. There was no time available for drying out the siege in spite of the fact that this was the traditional practice. When the temperature reached 100° C, the atmosphere of this furnace was soaking wet. Under these conditions it did not seem at all possible that the pots would survive. No trouble at all was experienced, however, the average pot life being well above that usually obtained. Later a second furnace was handled the same way with the same results.

The facts all indicated that the maintenance of moisture in the atmosphere surrounding a pot while heating up was of maximum importance in minimizing strain and that there was little to fear owing to too much moisture being present.

The problem then was one of methods of controlling the amounts of moisture introduced. An arch may require for combustion during the period in which we are interested about 1760 cubic feet of air per hour. This air under conditions of 20°F and 55% relative humidity contains only 8% as much moisture as at 85°F and 70% relative humidity. To raise the moisture content of the air to summer conditions it is necessary to add only two pounds of water per hour, corresponding to about .24 gallons. Any person who has undertaken the burning of fuel oil in as small quantities as this will appreciate the difficulty of obtaining the necessary control. Furthermore, it is to be noted that in order to hold the moisture content of the ingoing air constant, the amount of moisture added should not only tend continuously to increase as the air demanded for combustion increases with the temperature, but must be varied with temperature and humidity conditions which are constantly changing. These conditions can only be met exactly by using air of constant temperature and humidity which, of course, is out of the question.

The first attempts made consisted of placing orifices in a water line and allowing the water from the orifice to drop in the stream of ingoing gas. This was very troublesome due to stoppage, as such an orifice was about $\frac{1}{32}$ inch in diameter. An orifice was then substituted using high pressure steam. Even this resulted in a very small orifice which was subject to a varying percentage of moisture, the small amount being used causing it to stand in the pipes long enough for severe condensation. Next, water was boiled at a definite rate, allowing the steam

to enter the arch. This entailed the addition of a definite volume of water at definite time intervals to a small boiling device.

However, the results obtained from a few trials on one arch indicated that the checking of the pots was less severe. In view of the fact that such a crude device tended to improve conditions, we concluded (1) to install a $\frac{1}{4}$-inch steam jet in the offtake from the gas producer, making the steam connection in parallel with the blower jets, and (2) to make a direct steam connection to the arch. As we already used oil for heating the arch at very low temperatures, this steam connection was installed as a substitute for the atomizing air on the oil burner. The results obtained were very satisfactory. We found that fewer checks occurred and those that did occur were of no importance.

The system was then extended to cover the entire bank of arches and no limitation was placed on the fireman as to the amount of steam he might use at any temperature, his instructions simply being to keep the burners blowing steam at the lower stages of the firing.

While the addition of this steam might be expected to increase the fuel consumption of the arch, we have found that it forces the fuel into the firebox better, which appears to neutralize the expected loss. The use of this steam has prevented the overheating of the fireboxes which was inherent in the method used for control, resulting in a decided decrease in repair charges.

Our experience with pots and similar objects led us to consider the possibilities of firing intricate clay shapes by the same principle. On some very intricate glass feeding machine parts where checks would cause rejection of the part it was our custom to consume ten days in firing, the greatest care being used in the temperature control. We have recently tried muffling these parts with damp clay blocks, and have been able to secure more satisfactory firing and no checks with a firing period of six days. We have found that the supervision required and the experience necessary is far less and the difficulties minimized.

Corning Glass Works
Corning, N. Y.

A DEFORMATION STUDY OF VARIOUS ALUMINOSILICATES AND BOROSILICATES[1]

By Kai-Ching Lu

ABSTRACT

A brief review of the past literature on the thermochemical study of silicates, aluminosilicates and borosilicates was prepared. The present study includes the development of five ternary "deformation eutectics," which had the following compositions and deformation temperatures:

Molecular Formula	Approximate Deformation Temperature in °C.
$PbO : 0.254\ Al_2O_3 : 1.91\ SiO_2$	650
$ZnO : 0.225\ Al_2O_3 : 0.906\ SiO_2$	1360
$PbO : 0.238\ B_2O_3 : 0.78\ SiO_2$	415
$Na_2O : 1.29\ B_2O_3 : 1.73\ SiO_2$	570
$K_2O : 2.11\ B_2O_3 : 2.585\ SiO_2$	655

Cones were made and deformation was studied in the same manner as used with standard pyrometric cones. All eutectics developed are within the $2\frac{1}{2}$ molecular per cent limit. Combination of eutectics were also made but no further lowering of temperature was noticed. The results were discussed with special stress laid upon the relation between the various eutectics.

I. Introduction

The present investigation was undertaken to develop an enamel of low fusion temperature by a combination of several eutectics. The scope of this study was confined to the development of five ternary eutectics which constitute a part of the enamel composition. The idea is by no means a new one and the work is empirical.

The term "eutectic" or "deformation eutectic" is used throughout this paper to designate the composition which requires the lowest temperature to complete its deformation. A combination of these ternary eutectics was also made in proportions that would make an enamel.

Dealing with so complex a mixture as enamel, and with only a scarce amount of data in hand, the author is not able to declare at this stage any possibility that an enamel could be obtained from eutectic combinations, yet he is willing to unveil such light as he has.

II. Review of Literature

A review of the past literature of similar nature gives some idea of the thermochemical behavior of the chief constituents of enamel.

1. PbO-SiO_2 This system has been studied a good deal but no one paid much interest to the high silica side. Mellor[2] took

[1] A thesis presented for the degree of Master of Science, Ohio State University, 1925. Recd. Nov. 1, 1925.

[2] J. W. Mellor, A. Latimer and A. D. Holdcroft, *Trans. Ceram. Soc.* (Eng.), **9**, 129 (1909-10).

a series of observations on the melting of angular fragments of lead silicate glasses and found the deformation temperatures of the crystal mixtures, except pure PbO, roughly 200°C below their corresponding melting points. Mostowitsch[1] determined the ranges of formation temperature, melting points and freezing points. Cooper studied the thermal behavior[2] and the optical properties[3] and found a sound agreement. Hilpert studied this with Weiller[4] but he went through the same thing afterwards with Nacken[5] and made corrections. Beck[6] in his study of lead silicate glasses measured the softening temperatures of the PbO-SiO_2 mixtures at which the granular materials had run together sufficiently to permit the passage of electric current. Together with the author's result on deformation study obtained along the line PbO-SiO_2 in the ternary system PbO-Al_2O_3-SiO_2, the above data were shown graphically in Fig. 5 (See p. 40).

2. PbO-Al_2O_3-SiO_2 Eisenlohr[7] made a series of lead aluminosilicates with $1PbO : 0.1Al_2O_3$ constant and SiO_2 varying from 1.5 to 3. The deformation temperature of $PbO : 0.1Al_2O_3 : 1.5 SiO_2$ is the lowest being cone 018-019. But Pictorius[8] declared that Eisenlohr's work is inaccurate and cannot be checked. Beck[9] gave the following data on softening temperature (passability of electric current).

	$PbO \cdot SiO_2$	$PbO \cdot 2SiO_2$	$PbO \cdot 3SiO_2$
With 2.5% Al_2O_3	535°C	600°C	630°C
With 5% Al_2O_3	595°C	660°C	700°C

3. K_2O-SiO_2, K_2O-Al_2O_3-SiO_2 In Morey's[10] study of the system H_2O-K_2SiO_3-SiO_2, he obtained two binary eutectics on the straight line K_2O-SiO_2. The eutectic between K_2SiO_3 and $K_2Si_2O_5$ has a composition K_2O: $1.3SiO_2$ (775°C) and one between $K_2Si_2O_5$ and SiO_2 has a composition $K_2O : 4SiO_2$ (525°C). Rice,[11] in his deformation study of alkali silicates and alkali aluminosilicates, also gave two binary eutectics on the line K_2O-SiO_2, namely $K_2O : 1.29SiO_2$ (780°C) and $K_2O : 7.43SiO_2$ (880°C) and one ternary eutectic $K_2O : 0.276 Al_2O_3 : 6.978SiO_2$ (870°C).

---

[1] W. Mostowitsch, *Metallurgie*, **4**, 647-55 (1910).
[2] H. C. Cooper, L. I. Shaw and N. E. Loomis, *Jour. Amer. Chem. Soc.*, **42**, 461-73.
[3] H. C. Cooper, E. H. Kraus and A. A. Klein, *Jour. Amer. Chem. Soc.*, **47**, 273-85.
[4] S. Hilpert and P. Weiller, *Ber.*, **42**, 2969-77.
[5] S. Hilpert and R. Nacken, *Ber.*, **43**, 2565-73.
[6] Beck, Löwe and Stegmüller, *Arb. kais. Gesundh.*, **33**, 203-49.
[7] H. Eisenlohr, *Sprechsaal*, **43**, 389-92.
[8] H. Pictorious, *Sprechsaal*, **43**, 576-77.
[9] Beck, Löwe and Stegmüller, *loc. cit.*
[10] Morey and Fenner, *Jour. Amer. Chem. Soc.*, **39**, 1173-1229.
[11] B. A. Rice, *Jour. Amer. Ceram. Soc.*, **6**, 525-47 (1923).

4. Na_2-SiO_2, Na_2O-Al_2O_3-SiO_2

Morey and Bowen[1] determined two eutectics in the binary system Na_2SiO_3-SiO_2, namely Na_2O : $2.2SiO_2$ (847°C) and Na_2O : $5SiO_2$ (793°C). Rice's[12] study also gave two binary eutectics, Na_2O : $0.972SiO_2$ (830°C) and Na_2O : $4.579SiO_2$ (860°C) and a ternary eutectic Na_2O : $0.185\ Al_2O_3$: $4.55SiO_2$ (800°C).

5. ZnO-SiO_2, ZnO-Al_2O_3-SiO_2

Jäger and von Klooster[2] found two silicates, $2ZnOSiO_2$ with a melting point 1509°C and $ZnOSiO_2$ with a melting point 1437°C. Watts developed during his study of Bristol glazes[3] a ternary eutectic with a composition ZnO : $0.324Al_2O_3$: $0.81SiO_2$ and a deformation temperature around cones 12-13.

6. CaO-Al_2O_3-SiO_2

The work of the Geophysical Laboratory of Washington[4] done on this system is well known and very accurate. Hanna[5] studied the deformation temperature and found that the ternary eutectic of lowest deformation temperature coincides with that of the lowest melting point, namely, CaO : 0.348 Al_2O_3 : $2.489SiO_2$.

7. MgO-Al_2O_3-SiO_2

The work of the Geophysical Laboratory on this system[6] was also well recognized and of equal importance. Watts[7] obtained a ternary eutectic MgO : $0.392Al_2O_3$: $2SiO_2$ which fuses at cone 12.

8. BaO-Al_2O_3-SiO_2

According to Watts[8] the most fusible mixture has a composition between (*a*) 35% BaO, 10% Al_2O_3 and 55% SiO_2 and (*b*) 40% BaO, 10% Al_2O_3 and 50% SiO_2, both showing signs of fusion at cone 6. Eskola[9] gave in his study of the line system BaO-SiO_2 four compounds, three binary eutectics and a continuous series of solid solutions between $2BaO3SiO_2$ and $BaO2SiO_2$.

9. PbO-B_2O_3, PbO-B_2O_3-SiO_2

Thompson[10] found a compound $PbO3B_2O_3$ but no thermal study was made. Beck[11] gave the softening temperature data as follows:

	$PbO \cdot SiO_2$	$PbO \cdot 2SiO_2$	$PbO \cdot 3SiO_2$
With 5% $Na_2B_4O_7$	450°C	510°C	650°C
With 5% B_2O_3	460°C	540°C	600°C

[1] G. W. Morey and N. L. Bowen, *J. Phys. Chem.*, **28,** 1167.
[2] Jäger and von Klooster, *Sprechsaal*, **52,** 257.
[3] A. S. Watts, *Trans. Amer. Ceram. Soc.*, **18,** 632.
[4] Rankin and Wright, *Amer. Jour. Sci.*, **39,** 1-79.
[5] Hanna, *Trans. Amer. Ceram. Soc.*, **17,** 672.
[6] Rankin and Merwin, *Amer. Jour. Sci.*, **45,** 304.
[7] A. S. Watts, *Trans. Amer. Ceram. Soc.*, **19,** 453.
[8] A. S. Watts, *Trans. Amer. Ceram. Soc.*, **19,** 457.
[9] P. Eskola, *Amer. Jour. Sci.*, **4,** 331-75 (1922).
[10] H. V. Thompson, *Trans. Ceram. Soc.* (Eng.), **18,** 510-11.
[11] Beck, Löwe and Stegmüller, *loc. cit.*

10. CaO-B_2O_3 According to Guertler[1] there are three compounds, $CaO2B_2O_3$ (1012°C), $CaOB_2O_3$ (1100°C) and $2CaOB_2O_3$ (1225°C) and two eutectics, $CaO : 1.5B_2O_3$ (995°C) and $CaO : 0.887 B_2O_3$ (1070°C).

11. BaO-B_2O_3 In this system, Guertler[1] found one eutectic with a composition $1.5BaO : B_2O_3$ at 750°C.

12. K_2O-Na_2O-B_2O_3 Klooster[2] found the lowest fusion temperature of the mixture of KBO_2 and $NaBO_2$ at about 800°C containing equal parts of each.

13. Na_2SiO_3-$CaSiO_3$-$BaSiO_3$ Wallace[3] developed in the straight line Na_2SiO_3-$CaSiO_3$ two eutectics, 80% Na_2SiO_3, 20% $CaSiO_3$ at 938°C and 30% Na_2SiO_3, 70% $CaSiO_3$ at 1140°C. In the straight line Na_2SiO_3-$BaSiO_3$, there was an unbroken series of crystals, the mixture of the lowest fusion point contains 40% $BaSiO_3$. In the straight line $CaSiO_3$-$BaSiO_3$, Lebedew[4] found an eutectic of the composition 65.5% $CaSiO_3$ and 34.5% $BaSiO_3$ at 1040°C. In Eskola's[5] study on silicates of strontium and barium, he obtained a binary eutectic in the line system $CaOSiO_2$-$BaOSiO_2$ of the composition 27.5% $CaOSiO_2$ and 72.5% $BaOSiO_2$.

14. CaO-MgO-Al_2O_3-SiO_2 Besides the systems CaO-Al_2O_3-SiO_2 and MgO-Al_2O_3-SiO_2 the Geophysical Laboratory also carried out the studies on the systems CaO-MgO-SiO_2[6] and CaO-MgO-Al_2O_3[7], thus having the entire quarternary system completed.

15. K_2O-CaO-Al_2O_3-SiO_2 Hanna[8] obtained from combining eutectics of aluminosilicates a mixture of the composition $0.6K_2O$, $0.4\ CaO : 0.739Al_2O_3 : 4.829SiO_2$ with deformation started at cone 3 and completed when cone 3 was three-quarters down.

16. RO-PbO-Al_2O_3-SiO_2 Using different oxides for RO in the formula $0.3\ RO$, $0.7\ PbO : 0.1\ Al_2O_3 : 2\ SiO_2$ Eisenlohr[9] obtained a series of deformation temperatures: Na_2O, cone 019; K_2O, cones 016-017; BaO, cones 015-016; CaO, cone 015; and MgO, cone 013-014. Peddle[10] included in his article, "The Development of

---

[1] Guertler, *Z. anorg. chem.*, **40**, 337.
[2] H. S. von Klooster, *Z. anorg. Chem.*, **69**, 122.
[3] Wallace, *Z. anorg. Chem.*, **35**, 187.
[4] P. Lebedew, *Z. anorg. Chem.*, **70**, 301.
[5] P. Eskola, *Am. J. Sci.*, **5**, [4] 331-75 (1922).
[6] Ferguson and Merwin, *Am. J. Sci.*, **48**, 109.
[7] Rankin and Merwin, *Jour. Amer. Chem. Soc.*, **38**, 575.
[8] Hanna, *Trans. Amer. Ceram. Soc.*, **17**, 672.
[9] Eisenlohr, *Sprechsaal*, **43**, 389-92.
[10] C. T. Peddle, *J. Soc. Glass Tech.*, **4**, 1-107; **5**, 90.

Various Types of Glasses" both alkali and lead glasses but his study was confined to solubilities and refractive indices and very little was said about thermal changes.

III. Methods of Study

Materials The method of study was to make up cones and observe their deformation behavior when heated. The materials used, except B_2O_3 and SiO_2, were C. P. oxides and carbonates. The SiO_2 was potters' flint ground to pass 150-mesh.

All materials were weighed to an accuracy of 0.01 gram to make up a 100-gram batch.

According to Bleininger and Teetor[1] the B_2O_3-SiO_2 mixtures are typical glasses possessing no definite deformation temperatures and the increase of the ratio of $SiO_2 : B_2O_3$ from 2 : 1 to 2.2 : 1 results in a decided drop in solubility, indicating that some B_2O_3 has been rendered insoluble. With this in mind, a B_2O_3-SiO_2 mixture was prepared by fusing together a blend of ground flint and boric acid, 5% more of the latter than is required to make up the ratio 1 : 1. A chemical analysis of the resulting mass gave 46.85% SiO_2 which corresponds to $0.972B_2O_3 : SiO_2$. This was kept over a desiccator and stored up in an air oven held about 120°C. It was then used in the study of the borosilicate series.

The Cones The batch was ground, passed through a 100-mesh screen and thoroughly blended. For each member at least three cones were made from the batch using dextrin as a binder. For the alkali-borosilicate series, molasses seemed to be a better binder. All cones were made about two-thirds standard size except those undergoing a temperature above 2000°F and these were made about quarter size for use in a smaller furnace. In planting the cones in the plaque, a plastic mixture of dextrin and flint was used between the cone and the clay plaque to prevent reaction between the two.

The Furnaces The deformation behavior of the cones up to 2000°F was studied in an electrically heated muffle furnace.

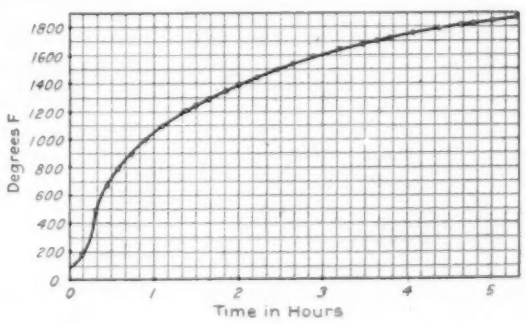


FIG. 1.

[1] A. V. Bleininger and P. Teetor, *Trans. Amer. Ceram. Soc.*, **14**, 210 (1912).

A Bristol direct reading pyrometer (Fahrenheit) and a base metal thermocouple 25H were used. A typical heating rate curve is shown in Fig. 1.

There were six outside resistances connected to the heating coil. By a rearrangement of the switches, hence changing the total resistance, a slower rate and constancy of temperature could be obtained as desired.

For temperatures above 2000°F a small Meker gas fired muffle was used.

The Data The deformation behavior of the cones was watched from a peep hole in the front door. Comparisons were made with Orton pyrometric cones. Temperature and time were recorded. The deformation was judged by the starting and finishing temperatures and time. With time accurately taken, the interval between "started" and "down" is a measure of the comparative viscosities.

All members on any of the triaxials shown in the following diagrams are given in molecular percentage.

After the member or group of members having a comparatively low deformation temperature was determined the limit of molecular difference between adjacent members was cut and the intermediates investigated. For the "5 and 10% limit" series, the cones were usually made from the raw materials (except B_2O_3) but for the 2.5% limit series, nearly all cones were made from blends of fritted end members. All series were studied to the 2.5% limit. Thus the deformation eutectic (within the 2.5% limit) was developed.

The portion of the cone not imbedded in the plaque was broken off and the rest ground to pass 100-mesh and analyzed. Duplicate analyses were made. The B_2O_3 content was obtained by difference.

IV. Series PbO-Al_2O_3-SiO_2(PAS)

As the PbO was introduced raw, part of it might volatilize during the heating and the clay plaque might absorb some from the bottom of the cone, thus causing a shift in the range of the deformation temperature, but as the percentage limits were not narrow in the first few heatings there is no considerable change in the order of deformation because of loss of lead. The area investigated in this system is shown in the Figs. 2, 3 and 4, indicating the 10, 5 and 2.5% limit respectively.

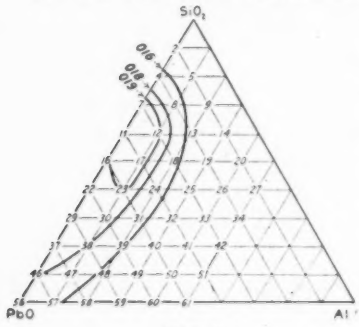


FIG. 2.

TABLE I

FIRST HEATING, SERIES PAS

Triangular area 16-56-61, 10% limit (Fig. 2)

(*a*) Deformation Data

Time	Temp. in F°	Started	Down	Time	Temp. in F°	Started	Down
A.M.							
10:30	on			12:13	1400	47	
10:40	200			12:20			47
10:50	500			12:22			39
11:05	800			12:24	1450	49(broken)	
11:22	1000			12:26		57	
11:30	1080	022		12:30		50(broken)	
11:40	1140		022	12:32		48	
11:50	1280	16		12:34	1500		57
11:55	1285	23		12:40		014, 40	
11:58	1290	30	23	12:43		60(broken)	
11:59		37, 29		12:45		58	014, 40
12:00	1300	22, 38	16, 30	12:48	1550		48
P.M.				12:55		61(broken)	
12:01		46		1:08	1600		58
12:02		018	22	1:10		010	
12:03			29, 46	1:20			010, 49
12:04			37	1:43	1700	06	
12:06	1350		38	1:55		59	
12:09		31	018	2:50	1800		06
12:10		39		3:00	1820 (off)		59 (half down)
12:12			31				

(*b*) Order of Deformation and Time between Started and Down

Starting Order	Down Order	Interval in minutes	Starting Order	Down Order	Interval in Minutes
16	23	3 (following the down order)	46	38	6
			31	31	3
23	30	2	39	47	7
30	16	9	47	39	12
29	22	2	57	57	8
37	29	4	48	48	16
22	46	2	58	58	23
38	37	5	59	—	—

TABLE II

SECOND HEATING, SERIES PAS

Rectangular area 2-11-27-51, 10% limit (Fig. 2)

(*a*) Deformation Data

Time	Temp. in F°	Started	Down	Time	Temp. in F°	Started	Down
12:00 M.	on			1:53			46
12:42	800			1:55	1370		22
12:58	1000			1:58		018	
1:08	1100			2:06	1420		018
1:14	1120	022		2:08			4
1:23			022	2:14		24	
1:25	1200	021		2:16	1450	8	
1:31			021	2:18		13(tipped)	18
1:34		020, 11		2:25		016	
1:35	1270	17		2:30			24
1:36		23		2:31			8
1:37		7	020, 11	2:32	1510	014	016
1:38		019, 12		2:45	1560	012	014
1:39			7, 17	3:15			012
1:40	1300	4		3:17		010	
1:41		37	12	3:20	1670	41(tipped)	
1:42			23	3:32			010
1:45		29		3:40		32	
1:46		38		3:43			32
1:47	1310	16		3:50	1720	08	
1:48		18, 30, 46	29, 37, 38	4:15	1780		08
1:49			019, 16	4:45		51(tipped)	
1:50	1340	22		4:50	1820	06	
1:52			30	5:10	1860(off)		06

(*b*) Order of Deformation and Time between Started and Down.

Starting Order	Down Order	Interval in Minutes	Starting Order	Down Order	Interval in Minutes
11	11	3 (following the down order)	16	30	4
			30	46	5
17	17	4	46	22	5
23	7	2	18	4	28
7	12	3	22	18	30
12	23	6	24	24	16
4	37	7	8	8	15
37	29	3	13	32	3
29	38	2	41	—	
38	16	2	32	—	

In this heating the members along the PbO-SiO_2 side deformed first, the order being 11, 17, 7 and 12. It showed a good check with first heating and only number 23 can be included in this group.

From the results obtained from the last two heatings the area of a low deformation temperature appeared limited to 7-12-16-23. Number 16 deformed together with 29, 37 and 38 but it came down before 22 and 30. Within this area seven intermediate members, *A* to *I* inclusive, were added.

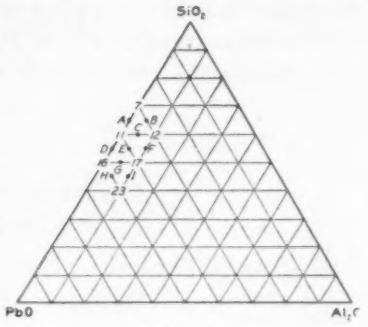


FIG. 3.

TABLE III

THIRD HEATING, SERIES PAS

Rectangular area 7-12-16-23, 5% limit (Fig. 3)

(*a*) Deformation Data

Time P.M.	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
1:30	on			2:55		019	
2:37		022		3:08	1250(off)		019
2:40	1120	021	022	2:47–2:55		all started	
2:44		020	021	3:00–3:08			all except 12
2:51			020				

The interval between start and down of all cones was so short that exact observations were impossible. The temperature taken was approximate. The only record obtained in those eight minutes was the deformation order.

(*b*) The starting order of deformation was not clear, so only the down order is worth recording. At cone 020 *C*, *E*, *G*, *H*, and 23 were down together and the order in which the others came down was 17, 11, 7, *I*, *A*, *B*, *F*, *D*, and 16.

At cone 019, 12 was $\frac{3}{4}$ down.

The area along the 5% Al_2O_3 line including *C*, *E*, *G*, *H*, and 23 seems to be quite near the eutectic composition. They came down at practically the same time and the rest came down after them within eight minutes. This does not necessarily mean that the low deformation mixture must lie on this line. As the cones were made from raw materials, it is quite possible a certain amount of PbO volatilized during the heating.

The heating rate of the fourth series was changed to get a slower

temperature increment in order to facilitate the observation of the deformation behavior within small temperature differences. The furnace was raised as usual to about 1000°F and then switched to a slow heating rate, raising the temperature about 20°F per hour.

TABLE IV

FOURTH HEATING, SERIES PAS. (Fig. 3)

Deformation Data

Time P.M.	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
1:30	on			3:37½			*C*
3:00	1000			3:38		019	*E*
3:20	1200 (slow rate)			3:40	1200		019
3:26	1200	020		3:50	1210	*H*	
3:30			020	3:52		*G*	
3:34		*C*		3:55		23	
3:36		*E*		4:00	1220(off)		

Within 2.5% limit, eleven members around *C* and *E* were made by blending fritted members *I*, *D*, 7 and 12.

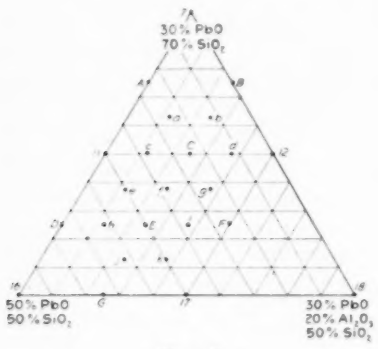


FIG. 4.

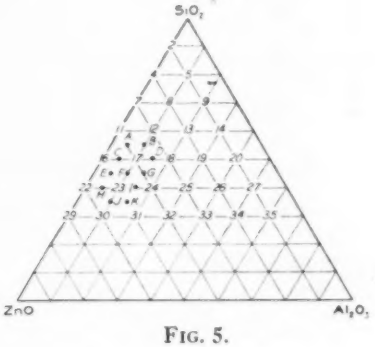


FIG. 5.

TABLE V

FIFTH HEATING, SERIES PAS. (Fig. 4)

Deformation Data

Time P.M.	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
4:00	on			5:22			020
5:00	1100			5:30	1200	*b*	*d*
5:10	1200	021		5:33		019, *C*	*g*
5:20	1200	020, *i*, *g*, *d*	021	5:35	1210(off)	*j*	019, *C*, *b*, *i*

TABLE VI

SIXTH HEATING, SERIES PAS

2.5% Limit (Fig. 4)

Deformation Data

Time	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
12:00 M.	on			1:50	1210	*b*	
P.M.				1:53			*d*
1:00	1000			1:55	1210		*g*
1:25	1200	020		1:58			019, *i*, *j*, *k*,
1:35			020				*E*, *C*
1:45	1200	019, all except *b*		2:00	1220 (off)		*f*, *b*($\frac{3}{4}$ down)

This heating was a check on the fifth heating. *d* again is the lowest deformation member. The molecular per cent is 32.5PbO, 7.5Al_2O_3 and 60SiO_2. The chemical analysis gives the weight per cent and the molecular per cent as follows:

	Weight per cent	Molecular per cent
PbO	60.8	31.6
Al_2O_3	7.1	8.0
SiO_2	31.45	60.4

The molecular formula according to the analysis is,

$$PbO : 0.254Al_2O_3 : 1.91SiO_2.$$

The deformation temperature is approximately 1200°F or 650°C.

TABLE VII

SEVENTH HEATING, SERIES PAS (Fig. 2)

Deformation Data

Time	Temp. in °F	Started	Down	Time	Temp in °F	Started	Down
12:00 M.	on			2:10	1230		D
P.M.				2:12			22, 37
1:30	1000			2:15	1250		7, 29
1:45		11		2:18			46
1:50	1200	22, *A*		2:25			16
1:52		46, 37, 29, *D*		2:30	1300	4	
1:56	1210		11	3:00	1400		4
1:57			*A*	6:00	2000	2[a]	
2:00		7, 16					

[a] Some PbO possibly volatilized during such a long heating.

This heating developed three binary eutectics, two high in PbO and one high in SiO_2. The deformation temperature curve is shown in Fig. 6, indicating a good agreement with the corresponding eutectics on the liquidus curve developed by Cooper and by Hilpert and Nacken. Mellor's observation though entirely different in nature gave the same result considering the effect of increasing the SiO_2 content. Beck's work was done on the passability of electric current through a granular mixture rather than the measurement of softening temperature.

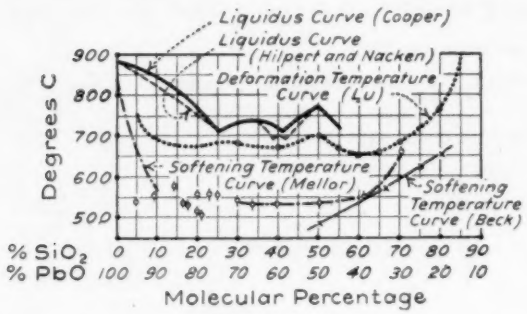


FIG. 6.

V. Series ZnO-Al_2O_3-SiO_2(ZAS)

A. S. Watts[1] had developed in his study of Bristol glazes a low fusion mixture with a molecular formula,

$$ZnO : 0.324Al_2O_3 : 0.81SiO_2$$

A series was made up using C.P. materials to check the eutectic. The area investigated in this system was shown in Figs. 5 and 7.

1. First Heating, Series ZAS

Area 2-29-35, 10%. Limit. (Fig. 5.)

As Prof. Watts' eutectic deforms at cones 12-13, the area around this composition was investigated at this temperature. The entire set was heated in a gas-fired kiln. At the end of thirty hours firing, the kiln was shut down between cones 12 and 13. Not a single one was down. Numbers 17, 23, 24, 30, 31 and 32 were the only ones that showed any signs of deformation.

2. Second Heating, Series ZAS (Fig. 5)

Having failed to bring down a single member in the first heating the object now was to locate the range of temperature at which they would probably deform. The six members located from the first heat were put into a gas fired Meker furnace and heated to cones 13-14. From the degree of their deformation, the order can be judged as follows:

23 flattened to a round ball	24 leaned, about ¾ down
17 flattened but with top remaining	30 tipped with top melted
31 just touched cone plaque	32 did not deform

From this heating 17 and 23 seemed to have the lowest deformation temperatures. It is then desirable to heat the entire set 2-29-35 to a

[1] A. S. Watts, *Trans. Amer. Ceram. Soc.*, **18**, 634 (1916).

higher temperature and at the same time study the intermediate members around numbers 17 and 23 within the 5% limit.

3. Third Heating, Series ZAS The entire set 2-29-35 heated to cones 12-13 in the first firing were put into a gas-fired kiln again and finished at cones 15-16 in 36 hours of firing. Still none of the cones showed any sign of deformation. All cones showed a cracked surface and some a glassy one. Undergoing such a long soaking fire, the ZnO is undoubtedly volatilized to a certain extent. The shrinkage of the cones was also remarkable as the heating temperature increases agreeing with Libman's[1] statement in his investigation on ZnO bodies. If the cones were heated up more rapidly as in the second heating, there will be less chance for the slow crystallization of ZnO which is probably responsible for the disintegration of the whole mass.

4. Fourth Heating, Series ZAS (5% Limit) Fig. 6 Eleven members were made around 17 and 23 and heated in the Meker furnace. The firing was finished at cones 12-13 with a period of three and one-half hours. From the degree of deformation the order was established as follows:

F	down and started to melt together,	*H, C, D, G*, 17	tipped only
K, I, 23	just down	*A, B, J*	did not deform
E	half down		

Within the 5% limit *F* deforms at the lowest temperature.

5. Fifth Heating, Series ZAS (2.5% Limit) Fig. 7 The limit was narrowed down to 2.5% and nine intermediate members were made from *F, K, I* and 23. The set was put into the Meker furnace as before and finished at cone 13 after a period of four hours heating. After being removed from the furnace, it was noticed that the cones had been placed too near the bottom. As a result of this, all the cones had their bottoms melted before the top started any deformation, hence the cones had fallen over without passing through a deformation process. From their angle of inclination, however, a difference in deformation is noticeable.

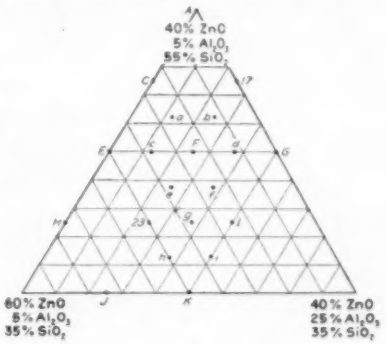


FIG. 7

F, e, K, I	inclined about 45°,
23, *a, d, c, g*	tipped slightly,
h, i, b, f	straight

[1] E. E. Libman, *Jour. Amer. Ceram. Soc.*, **5**, [8] 488-91 (1922).

6. Sixth Heating, Series ZAS

This was a check for the fifth heating. The same members were heated in the Meker furnace and finished at cones 11-12 in three hours. *e* was the first to deform, *F* and 23 followed immediately. When the cones were taken from the furnace at cone 12, the entire set was all deformed. This proved that the deformation temperature was lowest in this area and member *e* can therefore be established as the deformation eutectic of the system ZnO-Al_2O_3-SiO_2 within the 2.5% limit.

The molecular per cent of *e* is 47.5 ZnO, 10 Al_2O_3 and 42.5 SiO_2. The chemical analysis gives the following results:

	Weight per cent	Molecular per cent
ZnO	50.8	46.3
Al_2O_3	14.45	10.5
SiO_2	35.75	43.2

The molecular formula according to the analysis is,

$$ZnO : 0.225Al_2O_3 : 0.906SiO_2.$$

The deformation temperature at cones 11-12 is approximately 1360°C

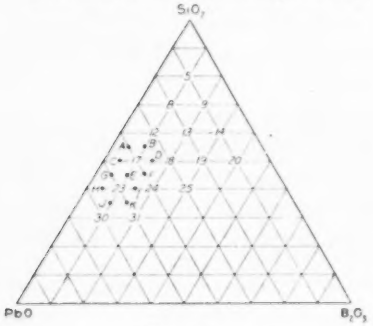


FIG. 8

VI. Series PbO-B_2O_3-SiO_2(PBS)

The B_2O_3 as mentioned before was not introduced as boric acid, but in a frit having the formula 0.972 $B_2O_3 : SiO_2$.

The area investigated is shown in Figs. 8 and 9.

TABLE VIII
FIRST HEATING, SERIES PBS. (Fig. 8)
Triangular area 5-17-20, 10% limit
Deformation Data

Time A.M.	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
9:00	on			10:50		019	020, 8
10:00(about)		12, 17(missed)	17	10:56	1200		019
10:10	950		12	11:02		018	
10:20	980	18		11:07			018
10:33			18	11:10	1300	14	
10:38	1040	022		11:15		13, 19, 20	
10:40		8	022	11:20	1360	9	19, 14
10:42		021					(broken)
10:46	1140	020	021	11:25	1390		13, 20

As the members 12, 17, and 18 started deformation before the muffle was barely red, their cones could hardly be seen without any outside source of light.

With special slow heating rate and an electric light inside the furnace the three members 12, 17, and 18 were heated and their deformation behavior observed.

TABLE IX
SECOND HEATING, SERIES PBS
Check on 12-17-18
Deformation Data

Time	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
A.M.				M.			
8:00	on			12:00	880		17
11:00	800			P.M.			
11:10	820			12:10	890	12	
11:50	880	17		12:20	900(off)		

TABLE X
THIRD HEATING, SERIES PBS, 5 % Limit (Fig. 8).
Deformation Data

Time	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
A.M.							
10:40	on			11:48		17	
11:20	400			11:50	810		*E*, 23
11:44		*E*		11:55	820	*A*	17
11:45		23		12:00	830	*B*	*A*

The area around 23 seems to be more interesting and the study of the higher PbO members was made in the next heating.

Eight members around 23 were included in the fourth heating of this Series.

TABLE XI
FOURTH HEATING, SERIES PBS
5% limit (Fig. 8)
Deformation Data

Time	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
12:00 M.	on			1:40			*I*
P.M.				1:42			17
1:00	300			1:50	830	31	
1:30	800			2:00	850	*G, H*, 24, 36	
1:32		*K*, 23		2:15			*G*, 31, 36
1:33		*E*		2:20			*H*
1:36	810	*I, J*	*E*, 23	2:30	900		24
1:37		17	*K*				
1:39			*J*				

The members, *E*, *K* and 23 were the lowest deformation mixtures within the 5% limit.

TABLE XII
FIFTH HEATING, SERIES PBS
2.5% limit (Fig. 9)
Deformation Data

Time	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
10:30	on			11:35	810	*g*	*f, j*
11:20	700			11:36		*a*	23
11:25		*i*		11:37		*e*	*E, K,*
11:27		*k*		11:39		*c, h*	*a, b, d*
11:30	780	*d, j*	*k*	11:40	830		*e, g*
11:32		*f, K,* 23	*i*	11:44	840 (off)		*c, h*
11:33		*E, b*					

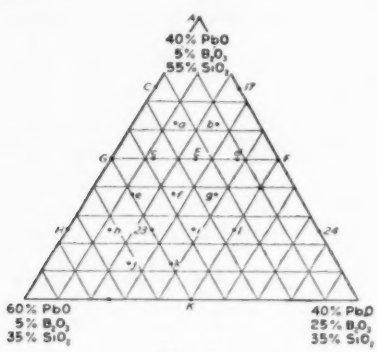


FIG. 9.

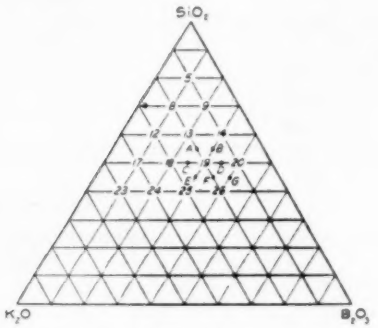


FIG. 10.

TABLE XIII
SIXTH HEATING, SERIES PBS
2.5% limit (Fig. 9)
Deformation Data

Time P.M.	Temp. in °F	Started	Down	Time P.M.	Temp. in °F	Started	Down
4:00	on			5:50	850	*E*	*j, f*
5:30	700			5:52		30	23, *E*
5:36	740	*k, i*		5:55	900	31	*K, J*
5:40	750	*f, j*	*k*	6:00	960		30
5:44	800	*K, J,* 23	*i*	6:20	1040		31

The sixth heating is a check for the fifth.

k again leads in deformation and hence is established as the deformation eutectic of this system within the 2.5% limit.

The molecular percentage of the member *k* is 50.0PbO, 37.5SiO_2 and 12.5B_2O_3. The chemical analysis (B_2O_3 from difference) gives the weight percentage and molecular percentage as follows:

	Weight per cent	Molecular per cent
PbO	77.55	49.25
B_2O_3	6.05	12.4
SiO_2	16.4	38.35

The molecular formula according to analysis is,

$$PbO : 0.238B_2O_3 : 0.78SiO_2.$$

The deformation temperature is approximately 780°F or 415°C.

But this is not the eutectic of the entire system PbO-B_2O_3-SiO_2. There will probably be still lower deformation mixtures in the high B_2O_3 area but they are deliquescent on account of their high B_2O_3 content.

VII. Series $K_2O_2B_3O$-SiO_2(KBS)

In making the cones, difficulties were encountered in the use of dextrin and water. The mass containing K_2CO_3 and the melted B_2O_3-SiO_2 mixture takes up water readily and sets into a hard conglomerate before any working could be done. This was not always the case. Most troubles occur in the high K_2O members. Later molasses was found to be a good substitute for dextrin.

The area of investigation in this system is shown in Figs. 10 and 11.

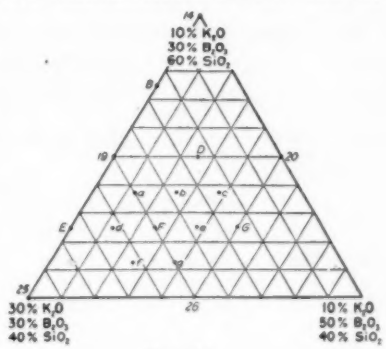


FIG. 11.

TABLE XIV

FIRST HEATING, SERIES KBS

Triangular area 5-17-20, 10% limit. (Fig. 10)

Deformation Data

Time P.M.	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
2:40	on			4:35		14	
4:00	1000			4:40	1220	018, 9	19
4:05		022		4:46			14, 20
4:15	1100	021	022	4:49			9
4:20		020	021	4:54	1300	13	018
4:24		18	020	5:10		016, 17	
4:27		019		5:25	1400	12	016, 17
4:30	1180	19, 20	18(bent to a hook)	5:40		014, 8	
4:32			019	5:45	1460(off)		014

In Table XV new members of less silica were included and the per cent limit cut down to five.

TABLE XV

SECOND HEATING, SERIES KBS. (Fig. 10)

Deformation Data

Time	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
A.M.							
9:40	on			11:52			*B*
10:40	800			11:54			018, 14, *A*
11:03	1000			11:56			20
11:26		19		M.			
11:28		019		12:00	1300	017, 25, *C*	*E* (broken)
11:30		14		P.M.			
11:33		*F*, 26		12:05		17	
11:35		*A*, 20		12:13			017
11:37	1180		*F*	12:15		016	17 (shrunk
11:38		*B*					to half
11:40	1200		019				size)
11:42		*D*	26	12:20		24	
11:45			19	12:25		18	
11:48		018		12:30	1400		016
11:50	1250	*E*	*D*	12:45	1450		24

TABLE XVI

THIRD HEATING, SERIES KBS (Fig. 11)

Deformation Data

Time	Temp. in °F	Started	Down	Time	Time. in °F	Started	Down
M.				P.M.			
12:00	on			2:10		*b*	
P.M.				2:12			*F*, *e*
1:00	800			2:15			019, 26
1:30	1000			2:17			*D*, *b*
1:45	1100			2:20	1240	018	*G*
1:50		*c*, *g*		2:28			018
1:56		020		2:30	1300	19	
2:00	1180		020, *c*	2:40		017	
2:05	1200	019, *G*	*g*	2:50	1350		017, 19
2:08		*D*, *F*, *e*, 26		2:55		*a*	

This heating establishes *c* as the deformation eutectic within 2.5% limit.

The third heating is checked by the following run.

TABLE XVII

FOURTH HEATING, SERIES KBS

2.5% limit (Fig. 11)

Deformation Data

Time	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
P.M.				P.M.			
3:00	on			4:55			021
4:30	1000	022		5:00	1200	020, *c*	
4:38			022	5:05		*g*	
4:45	1100	021		5:08		*e*	020, *c*

Time P.M.	Temp. in °F	Started	Down	Time P.M.	Temp. in °F	Started	Down
5:15		019, 26, *F*	*g*	5:28		*D*	26, *b*
5:18		*G*		5:35			*D*
5:20	1230	*b*	*e*	5:40			019, *G*
5:25			*F*	5:45	1280 (off)	018	

This is a very good check and establishes *c* as the deformation eutectic.

The molecular per cent of member *c* is $15.0K_2O$, $37.5B_2O_3$ and $47.5SiO_2$. But the chemical analysis gives the following results.

	Weight per cent	Molecular per cent
K_2O	23.7	17.6
B_2O_3	37.2	37.0
SiO_2	39.1	45.4

The molecular formula according to the chemical analysis is,

$$K_2O : 2.11B_2O_3 : 2.585SiO_2$$

The deformation temperature is approximately 1200°F or 655°C.

VIII. Series $Na_2OB_2O_3$-SiO_2(NBS)

Molasses was used as a binder but after a few trials dextrin and water were proved equally satisfactory though it could hardly be used with the extremely high Na_2O members.

It was not intended to study the high B_2O_3 members, hence the deformation eutectic developed can only be considered as the eutectic of the area shown in Fig. 12.

The area of investigation in this system was shown in Figs. 12 and 13.

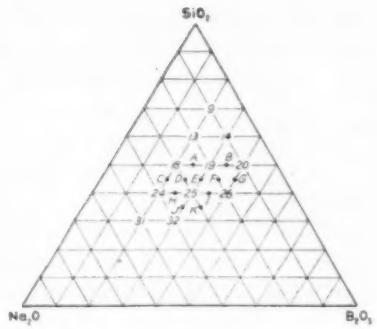


FIG. 12.

TABLE XVIII
FIRST HEATING, SERIES NBS
10% limit (Fig. 12)
Deformation Data

Time A.M.	Temp. in °F	Started	Down	Time A.M.	Temp. in °F	Started	Down
8:00	on			10:10			13
9:00	800			10:13			32
9:30	1000			10:15		24	019
9:37		022		10:18	1250	018	24
9:45	1100		022	10:25			018
9:55		19, 25, 26		10:30		20	14
9:58		020		10:40			20
10:00		14, 18	020, 25, 26	10:43		017	
10:02			19	10:50	1360 (off)		017
10:05	1200	019, 13, 32	18				

Members 19, 25 and 26 had the lowest deformation temperature.

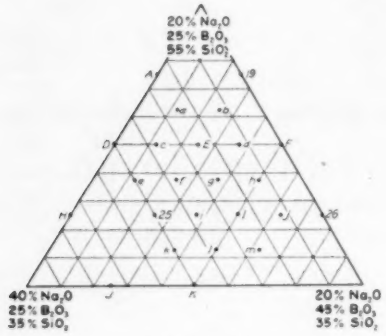


FIG. 13.

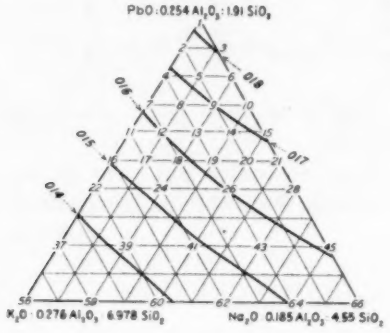


FIG. 14.

TABLE XIX

SECOND HEATING, SERIES NBS

5% limit (Fig. 12)

Deformation Data

Time	Temp. in °F	Started	Time	Temp. in °F	Started	Down
A.M.			P.M.			
10:40	on		12:15		*E*, 18	
11:10	500		12:20	1100	*J, H, K*, 25	022
11:45	900		12:25		022, *D, G*, 19	*E, I*
12:00	1000	*B, F, I*, 26	12:30		019, *A*	020, *B, F*, 19, 26
P.M.						
12:08		022	12:35		*C*, 14	019, *A, K*, J, 18, 25
			12:40	1200		*D, H*

Members *E* and *I* led in deformation.

TABLE XX

THIRD HEATING, SERIES NBS

(2.5% limit)

Deformation Data

Time	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
A.M.							
10:50	on			12:22	1120	*E*	*i, j*
11:35	750			12:24			*b, f, h, E*
11:55	940			12:25		*a*	*l, m, k, K*, 25
12:00	980	*g, d, h, j, m*					
P.M.				12:30	1150	18	*c, d, e, F*
12:05	1020	*b, l, F*, 26		12:35		020, *H, J*	*a*, 19, 26
12:10	1060	*c, e, f, i, I*, 022	*g*	12:40	1200	*D, G*	*H*
				12:45			020, *J*, 18
12:15	1100	*K*	022, *I*	12:48	1220		*D*
12:20		*k*, 19, 25					

This heating establishes member *g* as the deformation eutectic within the 5% limit.

The molecular percentage of the member *g* is 25.0Na_2O, 32.5B_2O_3 and 42.5 SiO_2. But the chemical analysis gives the weight percentage and the molecular percentage as follows:

	Weight per cent	Molecular per cent
Na_2O	24.2	24.8
B_2O_3	35.2	32.1
SiO_2	40.6	43.1

The molecular formula according to the chemical analysis is,

$$Na_2O : 1.29B_2O_3 : 1.73SiO_2.$$

The deformation temperature is approximately 1060°F or 570°C.

IX. Combination of Deformation Eutectics

As the original object of this investigation was to study the possibility of a synthetic enamel from eutectic combinations, a few combinations of the ternary eutectics developed were studied.

1. PbO-K_2O-Na_2O-Al_2O_3-SiO_2 The first of the series was made on a combination of the eutectic of the lead aluminosilicates developed by the author together with two eutectics of alkali aluminosilicates developed by B. A. Rice.[1]

Molecular Formula	Approx. Deformation Temp .°C
$PbO : 0.254Al_2O_3 : 1.91SiO_2$	650
$K_2O : 0.276Al_2O_3 : 6.978SiO_2$	870
$Na_2O : 0.185Al_2O_3 : 4.55SiO_2$	800

These eutectics were taken as end members and blends were made out from melts of these members. The members studied were shown in Fig. 14.

TABLE XXI
FIRST HEATING, SERIES PKNAS
20% limit (Fig. 14)
Deformation Data

Time P.M.	Temp. in °F	Started	Down	Time P.M.	Temp. in °F	Started	Down
1:00	on			3:20		017, 28	
2:30	1000			3:24		4, 43, 62, 64, 66	15
2:48	1160	020					
2:54			020	3:30	1360	016, 26, 41, 56, 58	017, 28
2:58	1200	019					
3:05		1		3:34			13
3:10		018, 6, 13	019, 1	3:37		24, 39	
3:15	1290	15, 45		3:40		11	4, 45
3:18			018, 6	3:45	1420	015	016, 26

[1] B. A. Rice, *loc. cit.*, p. 525.

Time	Temp. in °F	Started	Down	Time	Temp. in °F	Started	Down
3:52			64	4:20		37	22
3:55		22, 60	43	4:25		013	60
4:00	1460		11, 24	4:30			37
4:05			015, 66				
4:08		014	41	4:40	1580		013,58
4:15	1510		39, 62				
4:18			014	4:45	1600 (off)		56

Within the limit studied there is no sign of eutectic formation among the three aluminosilicates. The lead aluminosilicate was the first to deform. To study this a little further the limit was cut down to 10%.

TABLE XXII
SECOND HEATING, SERIES PKNAS
10% limit (Fig. 14)
Deformation Data

Time P.M.	Temp. in °F	Started	Down	Time P.M.	Temp. in °F	Started	Down
1:30	on			4:15		017, 21	10
3:05	1000			4:20		7, 8, 12, 14, 19, 20	2, 5, 15
3:20	1100						
3:50	1200	019, 1		4:25	1350		017, 9
3:58			1	4:30		016	13
4:00		2, 3, 6	019	4:35			14, 21
4:05		018, 10	3, 6	4:40		11, 16, 17, 18	4, 7, 8, 20
4:10	1300	4, 5, 9, 13, 15	018	4:45	1400 (off)		016, 12, 19

From these two heatings it is safe to say that so far as deformation temperature is concerned, there is no eutectic composition detectable by the means employed. The lead aluminosilicates leads all the rest in deformation. The members of high K_2O deform at much higher temperatures than those of high Na_2O. This uniformity was observed throughout the system and is indicated on the triaxial (Fig. 14).

2. PbO-CaO-ZnO-Al_2O_3-SiO_2 As the second of the series of eutectic combinations, the lead and zinc aluminosilicate eutectics developed by the author were taken to combine with the calcium aluminosilicate eutectic developed by Hanna.[1]

Molecular Formula	Approx. Deformation Temp. °C
$PbO : 0.254Al_2O_3 : 1.91SiO_2$	650
$ZnO : 0.225Al_2O_3 : 0.906SiO_2$	1360
$CaO : 0.348Al_2O_3 : 2.489SiO_2$	1240

The members investigated are shown in Fig. 15.

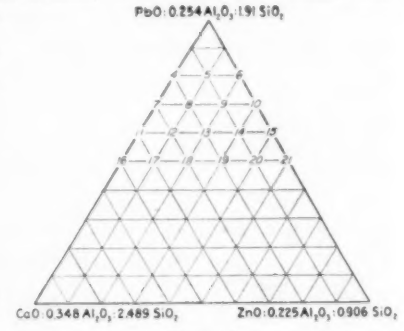


FIG. 15.

[1] Hanna, *Trans. Amer. Ceram. Soc.* **17**, 672 (1915)

TABLE XXIII

Deformation Data (10% limit)

Time P.M.	Temp. in °F	Started	Down	Time P.M.	Temp. in °F	Started	Down
1:00	on			3:03			5, 9
2:25	1000			3:05		15	018
2:42	1120	020		3:08		8, 13, 14	4, 15
2:44		6		3:10	1300	21	
2:46		019	020	3:15		7	8, 14
2:49			019	3:20		12, 20	13, 21
2:53		9, 10	6	3:25		017, 11	7
2:55		4, 5		3:30	1380		017, 12
2:58	1220		10	3:35		016, 14, 19	
3:00		018		3:38	1400		016, 20

Similar to the first series of combination, there was no sign of eutectic formation within the area studied. The members of high ZnO deformed at a little lower temperature than those high in CaO.

3. PbO-K_2O-Na_2O-B_2O_3-SiO_2 As the third and last of the series of eutectic combinations, the three borosilicate eutectics developed by the author were used.

Molecular Formula	Approx. Deformation Temp. °C
$PbO : 0.238B_2O_3 : 0.78SiO_2$	415
$K_2O : 2.11B_2O_3 : 2.585SiO_2$	655
$Na_2O : 1.29B_2O_3 : 1.73SiO_2$	570

The members studied are shown in Fig. 16.

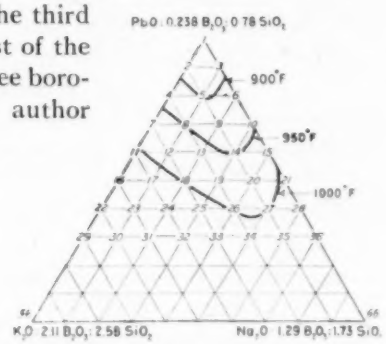


FIG. 16.

TABLE XXIV

Deformation Data 10% limit (Fig. 16)

Time A.M.	Temp. in °F	Started	Down	Time A.M.	Temp. in °F	Started	Down
10:10	on			11:28		32	21
10:55	700			11:30	1020	22, 30, 31, 36	11, 17, 24, 25, 28, 34, 35
11:05	820	1					
11:08		5	1				
11:10		2, 3, 9		11:33			16, 23, 33, 36
11:12		4, 6, 14					
11:13		8, 10, 20	2, 3, 5	11:35		29, 56	32
11:16	900	7, 12, 13, 15, 18, 19, 26, 27	6, 9, 10, 14	11:38			22, 31
				11:40		022, 66	30
				11:45	1120		022, 29
11:18		24, 25	4, 8	11:48			66
11:21	950	21	13	12:00	1180	020	
11:23			7, 12, 19, 20	P.M.			
11:25	1000	11, 16, 17, 23, 28, 33, 34, 35	15, 18, 26, 27	12:05	1200 (off)		020, 56

The result of this heating, though very similar to the previous series, was interesting. There was no deformation eutectic among the three borosilicates, but a series of low deformation mixtures was observed when the ratio of Na_2O:K_2O was varying from 2.33 to 4. This relation was shown in Fig. 16 by isothermal lines.

X. Summary

Two aluminosilicate and three borosilicate eutectics were developed within the limit of 2.5 molecular per cent difference. They had the following compositions and deformation temperatures:

(*a*) Molecular Percentage

PbO	ZnO	K_2O	Na_2O	B_2O_3	Al_2O_3	SiO_2	Approx. Deformation Temp. in °C
31.6					8.0	60.4	650
	46.3				10.5	43.2	1360
49.25				12.4		38.35	415
			24.8	32.1		43.1	570
		17.6		37.0		45.4	655

(*b*) Weight Percentage

PbO	ZnO	K_2O	Na_2O	B_2O_3	Al_2O_3	SiO_2
60.8					7.1	31.45
	50.8				14.45	35.75
77.55				6.05		16.4
			24.2	35.2		40.6
		23.7		37.2		39.1

The molecular percentage of these eutectics and several others of similar type developed by previous workers plotted on the triaxial is shown in Fig. 17. A combination of these eutectics was also attempted. By the three combinations made, though not complete, no sign of eutectic formation was found in any of them.

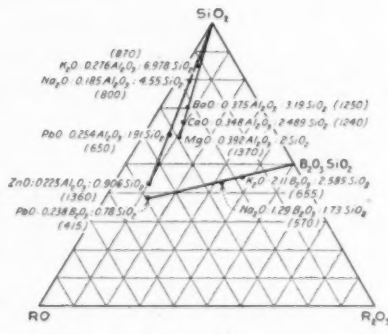


FIG. 17.

XI. Conclusion

A study of the results discloses several promising indications.

Referring to Fig. 17 on which all these eutectics are graphically indicated, we note that a line drawn through the points representing the compositions of the alkali aluminosilicate eutectics and the lead aluminosilicate eutectic

would, if extended, terminate in the component SiO_2. Similarly a line drawn through the points representing the compositions of the alkali borosilicate eutectics and the lead borosilicate eutectic would, if extended, terminate in the component $B_2O_3SiO_2$.

A similar relation appears to exist between the eutectics of CaO-Al_2O_3-SiO_2, BaO-Al_2O_3-SiO_2 and MgO-Al_2O_3-SiO_2, the straight line joining these points also terminating in the component SiO_2.

The eutectic of the zinc aluminosilicate lies on the extension of the lead and alkali aluminosilicate line but there is not enough evidence to justify including it in this group.

Again by observing the relative position of the eutectics of lead and alkali aluminosilicates and borosilicates on the triaxial, it is striking to notice that the same order prevails in both series, *i.e.* the order of their positions in the triaxial with regard to the different RO present in the eutectics.

This may be a coincidence between these series of aluminosilicates and borosilicates, but this simple fact will possibly furnish a new phase in the study of thermochemical properties of the silicates.

The recognized viscosities of the aluminosilicates and the borosilicates of the bases above mentioned are in the same order as the above relationship, and this may throw further light on this subject.

The viscosities of the aluminosilicates of the alkali earths are not definitely known and data on this would be necessary in order to consider the possible connection between the behavior of this series and the others.

The deformation temperature of these eutectics, though only approximately determined, offers another interesting feature to this problem. The deformation temperature of the eutectics grouped on the same straight line has either an increasing or a decreasing temperature gradient as the ratio of SiO_2 : RO increases. The PbO, Na_2O and K_2O, both aluminosilicates and borosilicates, belong to the former group while the CaO, BaO and MgO aluminosilicate series belongs to the latter.

It is possible that the deformation temperature is controlled by the combined chemical and physical properties of the RO members with Al_2O_3 and SiO_2. If this assumption is accepted, then it is not unreasonable to assume that this systematic grouping of eutectic compositions is also a function of their corresponding chemical and physical properties. A complete study of this phenomenon will no doubt require a thorough inquiry into the various RO-R_2O_3-SiO_2 systems and a careful observation of their individual thermal behavior.

In the combinations of eutectics studied, the viscosity seemed to be a dominating factor of the resulting melts and their thermal behavior, especially properties like deformation temperature, will probably be

overshadowed by the viscosity of the mass. There may be an eutectic of low melting point, but its high viscosity may cause the mass to require so long a time to complete deformation that the temperature has risen above its melting point.

From the results obtained thus far, it is reasonable to expect that in the construction of an enamel or a glass by combination of eutectics, as more RO members or their eutectics were introduced, there will be a point reached when the viscosity of the resulting glass cannot be diminished to any appreciable degree and consequently nothing be gained by the addition of more RO members so far as fusion temperature is concerned.

In studying the various components of an enamel or a glass, the combination of eutectics to determine the most fusible mixtures is one of the logical means of attacking the problem. The most fusible mixture may not necessarily be the most desirable one but fusibility should always be considered as a major factor.

MINERALOGY OF CLAY—I[1]

By J. Spotts McDowell

The Mineral Constituents of Clay[2]

ABSTRACT

A review of the literature on the microscopic examination of clays.

Accurate microscopic identification of the mineral constituents of clay is extremely difficult on account of the smallness of the particles. Relatively coarse grains of clay average .100 mm (.004 inch) in diameter; medium grains .020 to .025 mm (.0008 inch), and fine grains .010 mm (.0004 inch) or less.[3] Moreover, many clays contain much material so fine that the particles cannot be distinguished even with a high power petrographic microscope.

Clay has been defined as a mineral aggregate whose essential constituent is hydrated silicate of alumina, and which has certain physical properties. The minerals of this aggregate can be thought of as belonging in two classes: (1) essential constituents, and (2) accessory constituents. Variations in the relative amounts, composition and physical condition of these constituents impart to each type of clay its characteristic properties.

The term "essential constituents" as used here, will refer to those minerals which constitute what is generally spoken of as the "clay base." Unless some one of these minerals is present in amounts sufficient to give specific properties to the mineral aggregate, the latter cannot properly be called a clay. In any given clay, the essential constituent may consist of one mineral or of more than one; it may be mainly crystalline or mainly colloidal; it may comprise nearly the entire clay body, or it may be present in subordinate amounts. The microscopic studies of Galpin[2] and Somers[3] have shown that kaolinite and hydromica are the most important of the essential minerals. The common assumption that kaolinite is the only basic mineral of all highly aluminous clays is not correct. In some clays the base is mainly kaolinite; in most refractory clays, the base is a mixture of kaolinite and hydromica; the great bulk of many clays is hydromica. Halloysite is the base of a very few; other hydrous silicates of alumina have been mentioned as possible clay bases, but they are probably of slight or merely local importance.

The major accessory constituent in most clays is quartz. This is present in nearly every clay, and varies in amount from less than 1%

[1] Received November 9, 1925. For references in this paper see Bibliography, on p. 60.

to as much as 60%. Contrary to general belief, feldspar is not an important constituent of most refractory clays, and is not often identified under the microscope.[17]

The minor accessory constituents of refractory clays consist of a wide variety of minerals. Some of these are found in small proportions in nearly all clays; others are rarely present. Some of the more common minerals are pyrite, siderite, limonite, rutile, epidote, tourmaline and diaspore.

Essential Constituents

Kaolinite Kaolinite has the theoretical formula $Al_2O_3.2SiO_2.2H_2O$ corresponding to 39.5% Al_2O_3, 46.5% SiO_2, and 14% H_2O. Its hardness is 2 to 2.5 and specific gravity 2.6 to 2.63. The color is usually white. Kaolinite commonly occurs in plastic clay-like masses; under the microscope it is seen to consist of scales or plates which are often grouped in fan-shaped forms. It is always of secondary origin, and is assumed to have been derived in most cases from feldspar, although its possible derivation from numerous other minerals has been suggested.[7]

The mineral kaolinite can be identified in clays microscopically by its characteristic single and double refraction, and by its form. It occurs in single plates or scales, sometimes in fan-shaped aggregates or worm-shaped bunches. When very fine, it appears as minute transparent plates.

Colloidal Materials Many clays contain material which is so fine that the particles cannot be detected under the microscope. This material is assumed to be colloidal. From the index of refraction it has in some cases been identified as kaolinite. Some very plastic clays contain a large amount of colloidal matter.

Halloysite Halloysite is a clay-like mineral with a hardness of 1 to 2; specific gravity 2.0 to 2.2; luster, pearly or waxy. Its chemical composition is like that of kaolinite except that it contains more water (19.6%). The clay known as Indianaite from the Huron district, Indiana, and a few other clays, have been shown to contain large amounts of halloysite.

Mica A common constituent of clays is sericite, which is a fine scaly variety of muscovite mica, occurring in fibrous aggregates. It is believed to have been derived in most cases from the decomposition of feldspar.

In nearly all clays[2,3] the microscope reveals the presence of crystalline minerals which are distinctly micaceous, and whose single and double refraction are between those of muscovite and those of kaolinite. These minerals frequently occur in plates and fan-shaped bunches similar to

the fans of kaolinite, but of larger size. These crystals have been called "hydromica" by Galpin and Somers.[2,3] In a single section crystals can sometimes be seen forming an unbroken series whose birefringence varies from that of muscovite to that of kaolinite. Galpin has reported that prisms and plates of kaolinite frequently show ribs or plates of mica intergrown with those of the kaolinite. These ribs show every grade of variation from muscovite to kaolinite.

According to Somers, it is assumed that there is an isomorphous gradation from sericite to kaolinite with a gradual loss of potash and addition of water, and that hydromica represents the transition stage with kaolinite as the final product.[3] Hickling[13] refers to the established fact that muscovite does become hydrated, when immersed in pure water or water saturated with CO_2. He believes that the mica changes directly to kaolinite in the clay, for the following reasons:

1. There was mica but no kaolinite in feldspar.
2. There is no difference in form between the mica and kaolinite.
3. Prisms were observed which were mica at one end and kaolinite at the other.

A comparison of the chemical formulas and analyses of orthoclase feldspar, muscovite and kaolinite is of interest in showing that muscovite is intermediate in composition between the other two.

TABLE I

		Al_2O_3	SiO_2	K_2O	H_2O
Molecular Ratio	Orthoclase	3	18	3	0
	Muscovite	3	6	1	2
	Kaolinite	3	6	0	6
Chemical Analysis	Orthoclase	18.4%	64.7%	16.9	0%
	Muscovite	38.5	45.2	11.8	4.5
	Kaolinite	39.5	46.5	0	14.0

In both orthoclase and muscovite a portion of the potash is usually replaced by soda.

Major Accessory Constituents

Quartz (SiO_2) Nearly all clays contain some free silica in the form of quartz. In the residual clays quartz is particularly abundant; in pure kaolins and in some fire clays its percentage is negligible. The size of the individual grains varies in different clays, and in a few can be seen with the naked eye. Amorphous silica is found in some clays.

Diaspore The major accessory constituent of the nodule clays of Pennsylvania and of the burley clays of Missouri is diaspore ($Al_2O_3.H_2O$) instead of quartz. It occurs in the form of scattered grains.

Minor Accessory Constituents

Iron Compounds Common iron minerals in clays are pyrite (FeS_2), siderite ($FeCO_3$), and ferric oxide, anhydrous hematite (Fe_2O_3), or in various stages of hydration, limonite ($2\ Fe_2O_3.\ 3H_2O$) and other minerals). Other iron-bearing minerals such as biotite mica, hornblende and magnetite (Fe_3O_4) occur infrequently.

No clay is free from iron, which is the principal coloring agent in fired clay. White-firing clays contain from a few hundredths of a per cent to over 1% of iron; buff-firing clays from .5% to 4 or 5%; red-firing clays, 4 to 7%. The iron minerals may be present in either the colloidal or granular condition. Colloidal or disseminated iron produces an even color on firing; grains of iron minerals form iron spots. Ferric oxide and hydroxide tend to be disseminated throughout a clay; iron carbonate may be either disseminated or in grains; pyrite invariably occurs in granular form.

The fire clays contain most of their iron in the form of siderite or pyrite. However, where they are exposed to the air or to percolating waters, as in stock piles or on the outcrop of clay beds, these minerals eventually change to limonite. Siderite in fire clay occurs in the form of microscopic grains and as a film coating other minerals. Pyrite (Fe 46.6%, S53.4%) which is yellow can often be seen by the naked eye, and is called "sulphur" by clay miners. It occurs in large lumps, small grains or cubes, and in flat rosettelike forms.[7] This mineral is the cause of much difficulty in the firing of clay ware. Hydrated ferric oxide is most abundant in surface clays, or in the weathered outcrops of bedded deposits.

Other Minerals Nearly all clays contain some rutile (TiO_2). It sometimes occurs in prisms or grains .015 to .020 mm (.0006 to .0008 inch) in diameter,[3] more often as grains or needles .001 to .010 mm (.00004 to .00040 inch) in diameter and 5 to 6 times as long as wide. The number of these grains is large, but they represent only a small quantity of rutile. Minerals commonly found in clay, but in very small amounts, are tourmaline (a complex silicate of boron and aluminum); epidote (a hydrated lime-iron aluminum silicate); zircon ($ZrO_2.SiO_2$); and titanite ($CaO.TiO_2.SiO_2$). Other clays have been reported to contain varying amounts of calcite ($CaCO_3$), gypsum ($CaSO_4.2H_2O$), glauconite (a hydrated silicate of potash and iron) and garnet.

Constitution of Some Typical Clays

Flint Fire Clay Typical flint clays examined by Galpin were very finely crystalline, consisting of kaolinite in prisms, fans, and vermicular forms. The prisms were not infrequently ribbed

with hydromicas. Considerable difference was observed in the grain-size of flint clays from different districts. In that from Woodland, Pa., the kaolinite grains averaged .005 to .010 mm (.00020 to .00040 inch) in diameter, although there was much finer material. In normal flint clays other minerals are scarce, but always present. Badly corroded grains of quartz up to .090 mm (.0036 inch) diameter were observed; also a few zircon and tourmaline grains, rutile needles and muscovite plates.

Semi-plastic Fire Clay

The semi-plastic fire clay which occurs in the same bed with the flint clay at Woodland, Pa., is described as a felt of mineral plates of .005 to .200 mm (.00020 to .008 inch) diameter. Three prominent types of mineral grains were observed:

1. Large muscovite plates .100 to .250 mm (.004 to .010 inch) in diameter; conspicuous, but only small part of the clay.

2. The bulk of the clay consists of plates smaller than the above in a confused felt-like mass. They are believed to be hydromicas.

3. Considerable kaolinite in prisms, fans and plates is present; ribs of hydromica are common in the plates.

Quartz, zircon, tourmaline and rutile are present in small amounts.

Plastic Fire Clay

In the plastic fire clay examined by Galpin, hydromica was the most common mineral. None of the plates and grains exceeded .020 to .025 mm (.0008 to .0010 inch) in diameter; much of the clay was too fine to determine with the microscope.

Comparison of Fire Clays

According to Galpin,

> Comparison of the flint clays and their associates with other highly aluminous clays, shows that the main difference is in texture. In the flint clays the kaolinite crystals are knit together so tightly that when the clay is crushed they break out in aggregates rather than as individuals. In the semi-plastic clays, the crystals though larger than in the flint clays, are not so tightly interlocked and so become separated in grinding, producing some plasticity. In the plastic clays the crystalline particles are smaller and at the same time more or less separated.

It appears also that in clays of the fire-clay type the plastic clays contain more hydromica and less kaolinite than do the flint clays, and more colloidal material.

Other Clays

Somers[3] has made a microscopic examination of over 100 samples of American clays. Two minerals present in all were kaolinite and hydromica. In the white clay of Georgia, he found that kaolinite is usually abundant; hydromica, common; quartz, zircon and rutile scarce. In the white clays of South Carolina kaolinite is abundant, hydromica, common; quartz, variable; rutile, fairly common; zircon, scarce. The residual clays from the Cambrian schist of

eastern Pennsylvania contain abundant kaolinite; moderate to abundant hydromica; common to abundant quartz; rutile is common; zircon, tourmaline, epidote and titanite were observed but are scarce.

In an examination of china clays Schurecht[11] found that English china clay consists mostly of distinct crystalline plates and platy aggregates of kaolinite, whereas Georgia and South Carolina clays are constituted largely of colloidal kaolin aggregates. He attributes the distinctive properties of the English clay to its crystalline texture.

HARBISON-WALKER REFRACTORIES CO.,
PITTSBURGH, PA.

Bibliography

1. W. J. McCaughey, "The Mineralogical Examination of Clays," *Trans. Amer. Ceram. Soc.* **15,** 322 (1913).

2. S. L. Galpin, "Studies of Flint Clays and Their Associates," *Trans. Amer. Ceram. Soc.*, **14,** 301 (1912).

3. R. C. Somers, "Microscopic Examination of Clays," *Jour. Wash. Acad. Sci.*, **9,** (1910).

4. P. Carré, "Clays," *Ceramique*, **15,** 266 (1911).

5. L. Bertrand and A. Languine, "The Relation between the Chemical Composition, Microstructure and Ceramic Properties of Clays," *Compt. Rend.*, **169,** 1171 (1919).

6. Delage and Legatu, *Annale de L'ecole nationale D'agriculture de Montpelier*, **6,** 200 (1905).

7. H. Ries, "Clays, Their Occurrence, Properties and Uses," John Wiley & Sons, New York, 1906.

8. J. W. Mellor, "A Note on the Nomenclature of Clays," *Trans. Ceram. Soc.* (Eng.), **8,** 23 (1908-9).

9. J. D. and E. S. Dana, "A System of Mineralogy," 6th ed., John Wiley & Sons, New York, 1914.

10. J. Alexander, "Ultramicroscopic Examination of Some Clays," *Jour. Amer. Ceram. Soc.*, **3,** 612 (1920).

11. H. G. Schurecht, "The Microscopic Examination of the Mineral Constituents of Some American Clays," *Jour. Amer. Ceram. Soc.* **5,** 3 (1922).

12. W. G. Fearnsides, "Application of Petrographic Methods to the Study of Refractory Materials," *Trans. Faraday Soc.*, **12,** 148 (1917).

13. George Hickling, "China Clay: Its Nature and Origin," *Trans. Inst. Min. Eng.*, **36,** 10 (1908).

14. Edw. Orton, Jr., "The Rôle of Iron in Clay Burning," *Trans. Amer. Ceram. Soc.*, **5,** 377 (1903).

15. S. W. Johnson and J. M. Blake, "On Kaolinite and Pholerite," *Amer. Jour. Sci.*, 2nd ser., **43,** 351 (1867).

16. J. W. Macadam, "Analyses of Samples of China Clay (Kaolinite), Cornwall," *Mineralogical Mag.*, **1,** 76 (1885-7).

17. Wm. J. McCaughey, "The Mineralogical Examination of Coal Formation Clays," Geol. Surv. of Ohio, *Bull.*, **26,** 516 (1923).

18. Earl V. Shannon, "Note on the Mineralogy of Three Gouge Clays from Precious Metal Veins," *Proc. U. S. Nat. Mus.*, **62,** Article 15 (1923).

RATIONAL ANALYSIS OF CLAY—II[1]

By J. Spotts McDowell

Rational Analysis

ABSTRACT

A review of the literature on the rational analysis of clays. The methods of determining the rational analysis are shown to be inaccurate.

Ultimate and Rational Analysis Compared

The object of the "ultimate analysis" of clay is the determination of the various constituent oxides, such as silica, alumina, iron oxide, titania, lime, magnesia, alkalis and combined water. From a knowledge of the relative proportions of these oxides, certain inferences can be drawn regarding the properties of the material. Clays free from iron fire white, while iron tends to produce a buff or red color upon firing. Iron, lime, magnesia and alkalis tend to lower the melting point; hence a high content of these impurities is an indication of low refractory value. However, the ultimate analysis is unsatisfactory as a guide in judging the physical properties of a clay; for clays of similar analysis often exhibit decidedly dissimilar working and firing behavior.

Clays are mineral aggregates, and their characteristic properties depend upon the relative amounts, composition and physical condition of the constituent minerals. The ultimate analysis does not indicate what these minerals are. Iron, for example, is reported merely as "Fe_2O_3"; yet it may be present as siderite, as pyrite, as disseminated limonite, or in other minerals, each of which may have a different effect upon the properties of the clay. Silica in combination with other elements will exert an altogether different influence from uncombined silica.

Ceramists have long felt the need for a method which will resolve a clay into its mineral components, and have devised for this purpose the so-called "rational analysis." The earlier investigators made the rational analysis by direct laboratory processes; at present the view is generally held that calculation of the rational analysis from the ultimate analysis is preferable. The results of both methods are erroneous and more or less misleading, as they are based upon assumptions which are not in accordance with facts now known. The only way in which the constituent minerals can be positively determined is through microscopic studies. These, however, are only roughly quantitative, and do not give the exact proportion of the various minerals.

Methods of Rational Analysis

The methods of the rational analysis are based upon the assumption that clay consists mainly of "clay substance," or kaolinite, quartz and unde-

[1] Received November 9, 1925. For references in this paper see Bibliography, p. 64.

composed feldspar. Laboratory processes have been devised for separating clays into these fractions, through treatment with various strong reagents, particularly hydrochloric and sulphuric acids and alkali hydroxides.

H. S. Washington states,

> Following Mellor, the essential features of the 'rational' analysis are: digestion of the clay with hot, concentrated sulphuric acid and subsequent washing alternately with alkali and hydrochloric acid, to remove the 'clay substance'; this may be preceded by treatment with hot alkali to remove soluble silica, or with dilute hydrochloric acid, to remove the carbonates; and it may be followed by evaporation of the residue with hydrofluoric acid to remove quartz and other silica, and determination of the alumina, which is used as a basis for the calculation of the feldspar present.[6]

Various writers who apparently accept the assumptions upon which the rational analysis is based, nevertheless consider the laboratory methods faulty. The objections are these:[6] the different feldspars differ in solubility in the chemical reagents; some are quite insoluble, others readily soluble. Kaolin itself varies in its resistance to the reagents, as do the different kinds of silica which may be present. Other important factors which influence the rate of solution of the minerals are size of grain, the concentration of the reagents, the length of time and the temperature of treatment. According to Washington, the methods are

> scarcely susceptible of yielding satisfactory duplicate results except by chance, and even satisfactory duplication of results cannot be regarded as evidence, still less as proof, of their correctness, when the methods are seriously faulty.

Various writers maintain that the rational analysis can be more accurately determined by calculation from the ultimate analysis than by laboratory determination. In the calculation, potash is regarded as a derivative of orthoclase feldspar, and from the potash content the amount of orthoclase is calculated. Soda is assigned to albite; lime usually to anorthite; the remainder of the alumina, after the three feldspars

TABLE I

Ultimate Analysis		Rational Analysis Laboratory Determinaton		Rational Analysis Calculated[a]	
SiO_2	62.40	Clay Substance	66.33	Kaolinite	61.92
Al_2O_3	26.51	Feldspar	18.91	Orthoclase 5.56	
Fe_2O_3	1.14	Quartz	15.61	Anorthite 2.74	
CaO	.57				
MgO	.01		100.85	Total Feldspar	8.30
Alkalis	.98			Quartz	28.80
Loss on Ignition	8.80			Limonite	1.26
	99.91				100.28

[a] Alkalis assumed to be K_2O.

have been satisfied, to kaolinite; any silica above that required for the feldspars and kaolinite is assumed to be quartz. Iron oxide is calculated as limonite.

The two methods of determining rational analysis often exhibit considerable difference in the results, as shown by the references.[1,6]

The methods of rational analysis depend upon assumptions regarding the constitution of clay which are not supported by microscopic evidence at least so far as refractory clays are concerned. Most of these clays consist mainly of hydromica, kaolinite and quartz, and not of feldspar, kaolinite and quartz.[12] Galpin has determined microscopically that a semi-plastic clay from Woodland, Pa., consists mainly of hydromica and kaolinite, with small amounts of muscovite, quartz, rutile, zircon and tourmaline. No feldspar was observed. However, according to the calculated rational analysis, this clay appears to have the following constitution:

Kaolinite	73.9%	Rutile	3.2
Feldspar	11.4	Limonite	2.3
Quartz	9.2		
		Total	100.0

An accurate quantitative calculation of the mineral constitution of a clay cannot be made even by making use of a microscopic study and the ultimate analysis. The hydromica introduces considerable difficulty, as it appears to be not a definite mineral, but an isomorphous series between kaolinite and muscovite.

Wohlin[13] has analyzed certain earthy materials by determining the time-temperature curves of small samples heated in an electric furnace. Different types of materials were found to have distinctive curves. The lags were usually due to the evolution of water, the rapid rises to polymerization. By this method bauxite ($Al_2O_3.2H_2O$) was proved to be a mixture of gibbsite ($Al_2O_3.3H_2O$) and diaspore ($Al_2O_3.H_2O$). Perhaps this method can be applied further, by using it in conjunction with microscopic studies for the calculation of rational analysis.

Quantitative knowledge of the constitution of a clay, even if obtainable, would not be sufficient information upon which to predict its various properties. Much depends upon size of grain of the component minerals, and upon the proportion of colloidal matter.

Excess Silica The ratio of silica to alumina, and the amount of fluxing oxides, can be used as a crude index of the refractory quality of a clay. A few ceramists make use of the term "excess silica" or "free silica" to represent all of the silica above that required by the ratio $Al_2O_3 : 2\ SiO_2 = 102 : 120$. This procedure seems to be justified, since kaolinite, muscovite and hydromica are the only

minerals present in most clays which contain a large percentage of alumina; and in each of these the ratio of alumina to silica is Al_2O_3. $2SiO_2$, or 102 : 120. The "excess silica" therefore represents the amount of silica present which is not a part of some one of these minerals; it is largely quartz, but may be in part combined with some of the minor accessory minerals. The iron oxide, titania, lime, magnesia and alkalis may be grouped as "fluxing oxides." These decrease the refractoriness of a clay more when the amount of "excess silica" is high than when it is low.

The diasporitic clays contain "excess alumina" instead of "excess silica."

A specimen calculation of "excess silica," applied to the analysis quoted above is here given:

SiO_2	62.40	
Al_2O_3	26.51	
Fe_2O_3	1.14	Fluxing Oxides 2.70
CaO	.57	
MgO	.01	
Alkalis	.98	
TiO_2	not determined	
Loss on Ignition	8.80	

$$\text{Silica combined with alumina} = 26.51 \times \frac{120}{102} = 31.19\%$$

$$\text{"Excess silica"} \qquad 62.40 - 31.19 = 31.21\%$$

HARBISON-WALKER REFRACTORIES CO.,
PITTSBURGH, PA.

Bibliography

1. H. Ries, "The Ultimate and Rational Analyses of Clays and Their Relative Advantages," *Trans. Am. Inst. Min. Eng.* **28,** 160 (1898).

2. J. W. Mellor, "The Rational Analysis of Clays," *London Jour. Gas Lighting* **103,** 459 (1908).

3. H. Ries, "Notes on the Rational Composition of Clays," *Trans. Amer. Ceram. Soc.*, **9,** 772 (1907).

4. J. W. Mellor, "A Note on the Nomenclature of Clays," *Trans. Ceram. Soc.* (Eng.) **8,** 23 (1908-9).

5. Geo. Hickling, "China Clay: Its Nature and Origin." *Trans. Inst. Min. Eng.* **36,** 10 (1908).

6. H. S. Washington, "The Calculation of the Rational Analysis of Clays," *Jour. Amer. Ceram. Soc.* **1,** 405 (1918).

7. E. R. Buckley, "The Clays and Clay Industries of Wisconsin," Wis. Geol. and Natural History Survey, *Bull.* **7,** Pt. 1 (1901).

8. Jackson and Rich, "The Proximate Analysis of Clays," *Jour. Soc. Chem. Ind.* **19,** 1087 (1900).

9. H. G. Schurecht, "The Microscopic Examination of the Mineral Constituents of Some American Clays," *Jour. Amer. Ceram. Soc.* **5,** 3 (1922).

10. C. F. Binns, Notes on the Rational Analysis," *Trans. Amer. Ceram. Soc.* **8,** 198 (1906). (See p. 203.)

11. R. C. Purdy, "Examples Showing the Uselessness of Rational Analysis of Clays as a Means of Controlling Glaze Fit." *Trans. Amer. Ceram. Soc.* **14,** 359 (1912).

12. S. L. Galpin, "Studies of Flint Clays and Their Associates," *Trans. Amer.Ceram. Soc.* **14,** 301 (1912).

13. Wohlin, "Beitrage zur Kenntnis der Thermischen Analysen von Tonen, Bauxiten und einigen Verwandten Korpern," *Sprechsaal* **46,** 783 (1913).

Have You Any of These for Sale?

Transactions and Journals Out of Print

Volumes 2, 5, 8, 9, 10, 11, 12, 14, 18 and 19 of the *Transactions of the American Ceramic Society* are out of print. As we have received several requests for these numbers $5.00 will be paid for each copy on receipt in the Secretary's office.

The January and June, 1923 and the January, February, 1924 issues of the Journal are also out of print; 60 cents will be paid for each copy received by

General Secretary,
Lord Hall, O. S. U.
Columbus, Ohio.

CERAMIC ABSTRACTS

Compiled by the

AMERICAN CERAMIC SOCIETY

ROSS C. PURDY, Editor
EMILY C. VAN SCHOICK, Asst. Editor

ABSTRACTORS: OLAF ANDERSEN, A. A. AYARS, C. E. BALES, W. M. CLARK, S. S. COLE, R. R. DANIELSON, H. G. FISK, F. C. FLINT, PERRY D. HELSER, C. J. HUDSON, F. G. JACKSON, W. R. KERR, R. M. KING, S. KONDO, A. H. KUECHLER, R. D. LEITCH, J. T. LITTLETON, JR., M. E. MANSON, T. N. MCVAY, R. J. MONTGOMERY, LOUIS NAVIAS, O. P. R. OGILVIE, E. E. PRESSLER, W. E. RICE, W. SCHMIDT, H. G. SCHURECHT, D. E. SHARP, H. F. STALEY, H. H. STEPHENSON, E. J. TE PAS, A. E. R. WESTMAN, F. A. WHITAKER.

Vol. 5 | January, 1926 | No. 1

Author Index[1] to Ceramic Abstracts for January

Aarnio, B. ... 35
Agnew, J. B. and Oeffner, A. A. ... 33
Andrew, J. H. and Higgins, R. ... 15
Armstrong, P. A. E. ... 14
Arthur, E. P. ... 32
Avery, C. L. ... 5
Azbe, V. J. ... 7

Bardenheuer, P. and Ebbefeld, C. ... 12
Barth, W. ... 35
Bass, J. ... 6
Belaiew, N. T. ... 12
Berge, A. ... 9
Berger, E. E. ... 8
Bertrand, L. ... 34
Bigot, M. A. ... 34, 37
Blanchette, E. ... 24
Bodin, V. ... 26
Bodin, V. and Gaillard, P. ... 32
Bonyoucós, G. J. ... 35
Booraem, J. F. ... 25
Born, F. ... 20
Breémond, M. P. ... 34
Brooks, J. ... 15
Brunner, A. ... 13

Castelli, G. ... 37
Chalmers, H. B. ... 20
Chevenard, P. and Portevin, A. ... 12
Cikritova, M. and Sandra, K. ... 37
Congdon, L. A., Guss, A. B. and Winter, F. A. ... 35
Cottringer, P. and Collings, W. R. ... 10
Coutant, J. G. ... 39
Cramer, A. N. ... 21
Croll, A. G. ... 10

Dale, A. J. ... 25
Damour, M. E. ... 32
Dimand, M. S. ... 5
Doughty, I. N. ... 25
Duesing, F. W. ... 14
Dümmler, K. ... 28, 33

Eijssen, A. F. ... 6
Emery, W. ... 26, 31

Farish, W. A. ... 28
Farris, P. C. ... 25
Flournoy, S. I. ... 24
Fox, C. S. ... 27
Fox, J. H. ... 21
Frey, O. ... 9
Fuwa, K. ... 17, 18, 19

Geller, R. F. ... 38
Gelstharp, F. ... 22
Gessner, A. ... 9
Goerens, P. and Jungbluth, H. ... 11
Goulding-Brown, H. ... 20
Green, A. T. ... 32

Haegermann, G. ... 9
Hagen, M. ... 33
Halse, E. ... 33
Hamilton, D. C. ... 23
Hannam, G. F. ... 31
Hastreiter, J. ... 21
Henroz, A. ... 29
Hermanns, H. ... 27
Hill, J. M. ... 33
Huestis, T. B. ... 24
Hüttig, G. F. and Kükenthal, H. ... 31

I. L. ... 20

Johnston, J. ... 27
Joseph, A. F. ... 34

Kalk, W. ... 9
Kautsky, H. and Herzberg, G. ... 36
Knight, A. B. ... 23
Knuth, Michr and Stephan ... 39
Komuro, M., Kano, S., Horie, H. and Inokuchi, S. ... 6
Kondo, S. ... 2, 3, 4, 33
Kucera, P. ... 22

LaFrance, R. ... 20
Lapp, G. W. ... 30
Lea, H. I. and Humphrey, C. W. ... 37
Libby, G. N. ... 37
Lissner, A. and Horny, R. ... 11
Litinsky, L. ... 28
Little, A. D. ... 38
Loichot, P. F. ... 32
Lorenz, R. and Herz, W. ... 36
Lynch, J. W. ... 23

McGovern, D. F. ... 2
Mackay, E. ... 24
Marlett, W. W. ... 40
Mehl, R. F., Whitten, J. L. and Smith, D. P. ... 27
Miller, L. B. ... 32
Miller, W. M. ... 30
Monro, W. L. ... 23
Mossay, P. A. H. ... 22
Mueller, M. ... 32
Mulholland, V. ... 22
Myler, S. A. ... 28

Nacken, R. ... 35
Nesselmann, K. ... 36

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that the abstract was secured from *Chemical Abstracts* by coöperative agreement.

Author Index to Ceramic Abstracts for January (*Continued*)

Oberhoffer, P. 13
Oberhoffer, P. and Wimmer, A. 12

Pascarello, M. L. 30
Pasche, G. 33
Patterson, R. A. 36
Pease, C. M. 8
Pfeiffer, R. 29
Pomilio, U. and Giordani, F. 37
Powell, J. C. 21

Richter, G. M. A. 5

Sauveur, A. 12, 14
Schaefer, W. A. L. 28
Schmick, H. 14
Schmidt, A. 24
Schüz, E. 11
Schwarz, R. 31
Seabury, W. W., DeLeeuw, A. L. and Hall, J. A. 2
Sherban, D. V. 31
Shioda, K. and Shimpei, K. 7
Sibley, R. L. 40
Sieurin, S. E. 28
Simpson, J. T. 31
Sliupas, K. and Boys, C. V. 30
Springer, L. 16
Spurrier, H. 40

Steinberg, S. S. 2
Strauss, B. 14
Sugie, J. 19
Suzuki, F. 7

Tammann, G. 17
Test, L. A. and Scoles, D. L. 37
Thies, H. R. 35
Thornberry, M. H. 33
Trostmann, C. 29
Turner, W. E. S. 16, 20

Va 38
Von Rohr, M. 20

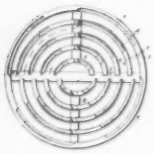
Ward, A. C. 29
Wataya, M. 26
Weaver, R. A. 15
Weber, H. M. 31
Weightman, H. E. 27
Weimer, R. 11
Welo, L. A. and Baudisch, O. 36
Wever, F. 13
White, A. H. 9
Wiesner, S. 37
Witte, R. 33
Wolf, J. 32

Abrasives

Centerless grinding. W. W. Seabury, A. L. DeLeeuw and J. A. Hall. *Mech. Eng.*, **47** [11], 943 (1925).—This is a discussion of the paper "The Theory and Practice of Centerless Grinding" which appeared in *Mech. Eng.* **47** [9], 695 (1925). C. J. H.

The manufacture of carborundum at the "Poroguy" electrometallurgical plant. S. S. Steinberg. *Messager ind. métaux russes* Nos. 4-8, 133-41 (April-Aug., 1923); *Rev. metal.* **22** (Extraits), 349-50 (1925).—With a $3\times1.5\times1$ m. furnace, a 450×450 mm. core, and a charge of charcoal 75, quartz 93, sawdust 18.5, NaCl 12.75 pounds, there were obtained 20-25 pounds of carborundum in 15-8 hrs. with a consumption of 6000-7000 kw. hrs. (*C.A.*)

PATENT



Emery wheel. Daniel Frederick McGovern. U. S. 1,561,555, Nov. 17, 1925.

An abrasive wheel having on its working face a plurality of spaced flanges, the space between said flanges constituting abrasive feed channels, said flanges having an abrasive lead extending from their forward ends opening inwardly into said feed channels, the rear walls of said leads being rearwardly beveled.

Art

Iron aventurine glaze. Seiji Kondo. (The Tokio Higher Technical School). *Bull.* No. 3, 1-12 (1925).—I. Fritted glazes $\begin{Bmatrix}0.50\ Na_2O\\0.25\ BaO\\0.25\ CaO\end{Bmatrix}$ $\begin{Bmatrix}0.05\ Al_2O_3\\0.50-0.10Fe_2O_3\end{Bmatrix}$ $\begin{Bmatrix}2.00-2.80\ SiO_2\\1.00-0.20\ B_2O_3\end{Bmatrix}$

(1) SiO_2 retards the production of the aventurine. B_2O_3 favors it, but its excess makes the crystals coarse. The best propns. for cone 05a − 1a are $\begin{Bmatrix}2.00\ SiO_2\\0.20\ B_2O_3\end{Bmatrix}$. (2) At least

$0.30Fe_2O_3$ is required. II. Fritted glazes $\left\{\begin{matrix}0.50Na_2O\\0.25BaO\\0.25CaO\end{matrix}\right\}0.05-0.25Al_2O_3\ \left\{\begin{matrix}0.50-0.10Fe_2O_3\end{matrix}\right.\ \left\{\begin{matrix}2.50SiO_2\\0.50B_2O_3\end{matrix}\right.Al_2O_3$ retards the crystn. However, it keeps the crystals fine and widens the range in Fe_2O_3. III. Fritted glazes $\left\{\begin{matrix}0.30Na_2O\\0.70-0.10PbO\\0.00-0.60CaO\end{matrix}\right\}\ 0.05Al_2O_3\ \left\{\begin{matrix}0.50-0.10Fe_2O_3\end{matrix}\right.\ \left\{\begin{matrix}2.00SiO_2\\0.00-0.50B_2O_3.\end{matrix}\right.$ B_2O_3 encourages crystn. IV. Source of iron in fritted glaze $\left\{\begin{matrix}0.50Na_2O\\0.25BaO\\0.25CaO\end{matrix}\right\}\ 0.05Al_2O_3\ \left\{\begin{matrix}0.50Fe_2O_3\end{matrix}\right.\ \left\{\begin{matrix}2.00SiO_2\\0.50B_2O_3\end{matrix}\right.$

(1) Metallic iron is most effective; however, the crystals are not well-defined and contaminated with amorphous ppt. (2) $FeCO_3$ is next effective and produces nice crystals. FeO is less effective. (3) Fe_2O_3 is least effective. V. Fritted glazes $\left\{\begin{matrix}0.25-0.00K_2O\\0.25-0.50Na_2O\\0.25-0.00BaO\\0.25-0.50CaO\end{matrix}\right\}$ $0.05Al_2O_3\ \left\{\begin{matrix}0.60-0.30Fe_2O_3\end{matrix}\right.\ \left\{\begin{matrix}2.00SiO_2\\0.20B_2O_3\end{matrix}\right.$ (1) The best glazes were obtained with $\left\{\begin{matrix}0.25K_2O\\0.25Na_2O\\0.50CaO\end{matrix}\right\}$ $0.05Al_2O_3\ \left\{\begin{matrix}0.45-0.50Fe_2O_3\end{matrix}\right.\ \left\{\begin{matrix}2.00SiO_2\\0.20B_2O_3\end{matrix}\right.$ fired to cone 03a and cooled quickly. (2) Slow cooling is not necessary. (3) Ferruginous bodies favor the crystn. and the glazes appear finer than those applied on porcelain bodies. VI. Fritted glazes $\left\{\begin{matrix}0.25K_2O\\0.25Na_2O\\0.50CaO\end{matrix}\right\}\ 0.05Al_2O_3\ 0.40-0.55Fe_2O_3$ $\left\{\begin{matrix}2.00SiO_2\\0.20B_2O_3\end{matrix}\right.$, with varying propns. of CaO, CuO and UO_3. An excess of the colorants makes the crystals too minute and injures the luster. Fine glazes were obtained with UO_3. VII. Fritted glazes $\left\{\begin{matrix}0.25K_2O\\0.25Na_2O\\0.50CaO\end{matrix}\right\}\ 0.00-0.15Al_2O_3\ 0.45Fe_2O_3\ \left\{\begin{matrix}2.00SiO_2\\0.20B_2O_3.\end{matrix}\right.$ The best result was obtained with $0.05Al_2O_3$. VIII. Aventurine glazes on biscuited stoneware bodies with Fe_2O_3-slip on their surfaces. The expt. failed to give any particular result. IX. Addition of the prepd. Fe_2O_3-crystals to fritted glaze $\left\{\begin{matrix}0.25K_2O\\0.25Na_2O\\0.50BaO\text{-}CaO\text{-}PbO\end{matrix}\right\}0.05Al_2O_3\ \left\{\begin{matrix}2.50SiO_2\\0.50B_2O_3.\end{matrix}\right.$ (1) The frit dissolves the crystals and they lose clear outlines. (2) The soly. is least when RO is solely CaO; PbO follows it; it is greatest in BaO frit. S. K.

Chrome aventurine glaze. SEIJI KONDO. (The Tokio Higher Technical School.) *Bull.* No. 3, 13-21 (1925).—I. Fritted glazes $\left\{\begin{matrix}0.25K_2O\\0.25Na_2O\\0.50RO\end{matrix}\right\}\ 0.05Al_2O_3\ 0.02-0.10Cr_2O_3\ \left\{\begin{matrix}2.50SiO_2\\0.50B_2O_3\end{matrix}\right.$

(1) No crystal appeared when RO = Ba-CaO-MgO. Slight aventurine was obtained at cones 010a – 1a when RO = PbO. (2) Only a part of Cr_2O_3 separates in cryst. form, most

of it being pptd. as amorphous grain. II. (1) Fritted glazes $\left\{\begin{matrix}0.25K_2O\\0.25Na_2O\\0.50PbO\end{matrix}\right\}0.05Al_2O_3$ $0.02-0.10Cr_2O_3$ $\left\{\begin{matrix}xSiO_2 & x=1.65\\yB_2O_3 & y=0.60\end{matrix}\right.$ were the best propns. for the production of the aventurine. (2) $0.02-0.04Cr_2O_3$ was completely or almost completely dissolved at cone 5a. III. Addition of $0.02-0.10$ equiv. of prepd. Cr_2O_3-crystal to frits $\left\{\begin{matrix}0.25K_2O\\0.25Na_2O\\0.50BaO\text{-}CaO\text{-}PbO\end{matrix}\right\}0.05Al_2O_3$ $\left\{\begin{matrix}2.50SiO_2\\0.50B_2O_3\end{matrix}\right.$. (1) The added crystal sank to the bottom. (2) The aventurine effect was given by the recrystn. of the dissolved Cr_2O_3 in all glazes when they had been cooled rather quickly. (3) The best propns. of RO and Cr_2O_3 were $0.25BaO-0.25CaO$ and $0.08-0.10Cr_2O_3$. IV. Addn. of $0.06-0.10$ equiv. of the prepd. crystal to frits $\left\{\begin{matrix}0.25K_2O\\0.25Na_2O\\0.25BaO\\0.25CaO\end{matrix}\right\}$ $0.05Al_2O_3$ $\left\{\begin{matrix}1.75-2.50SiO_2\\0.50B_2O_3\end{matrix}\right.$ (1) The crystal was not suspended, though it was ground pretty fine. (2) The best amt. was $0.10Cr_2O_3$. (3) The glazes look finer on chrome bodies than on white ones. V. Addn. of the prepd. crystal to frits $\left\{\begin{matrix}0.25K_2O\\0.25Na_2O\\0.50CaO\end{matrix}\right\}0.05Al_2O_3$ $0.04-0.08Cr_2O_3$ $\left\{\begin{matrix}1.65SiO_2\\0.30B_2O_3\end{matrix}\right.$. The aventurine glazes with clean surfaces were obtained at cone 12 when 0.2 and 0.5 equiv. of the crystal were added to the frits contg. 0.08 and 0.05 equiv. of Cr_2O_3 resp. VI. Fritted glazes $\left\{\begin{matrix}0.09K_2O\\0.41-0.61Na_2O\\0.50-0.30CaO\end{matrix}\right\}0.09Cr_2O_3$ $\left\{\begin{matrix}1.60-2.60SiO_2\\0.50-0.00B_2O_3\end{matrix}\right.$. (1) The aventurine appeared in glazes rich in B_2O_3 and alkalis. (2) The best result was obtained with the glaze $\left\{\begin{matrix}0.09K_2O\\0.41Na_2O\\0.50CaO\end{matrix}\right\}0.09Cr_2O_3$ $\left\{\begin{matrix}1.80SiO_2\\0.40B_2O_3\end{matrix}\right.$ fired to cone 8. VII. Fritted glazes $\left.\begin{matrix}0.7\text{-}0.3K_2O\\0.3\text{-}0.7CaO\end{matrix}\right\}\left\{\begin{matrix}0.0\text{-}0.5Al_2O_3\\0.1Cr_2O_3\end{matrix}\right\}$ $2.6\text{-}4.0SiO_2$. Weak aventurine appeared in glazes poor in CaO, Al_2O_3 and SiO_2.

Chromate glaze. SEIJI KONDO. (The Tokio Higher Technical School.) *Bull.* No. 3, 23-26(1925).—I. Glazes $\left\{\begin{matrix}0.90PbO\\0.10CaO\end{matrix}\right\}0.20Al_2O_3$ $0.50SiO_2$ were fired to cone 505a-5a $\left\{\begin{matrix}\\0.01\text{-}0.45Cr_2O_3\end{matrix}\right.$

(1) On vitrified porcelain, the immature glazes had red color which had a strong tendency to change to green with progress of melting. (2) All of the immature glazes had red needles; most of the mature glazes had green or red crystals with shapes of leaves, trees or flowers. (3) No crystals appeared on porous biscuits. II. Glazes $\left\{\begin{matrix}0.90\text{-}0.50PbO\\0.10\text{-}0.50CaO\end{matrix}\right\}$ $\left.\begin{matrix}0.05Al_2O_3\\0.02\text{-}0.25Cr_2O_3\end{matrix}\right\}0.50\text{-}2.00SiO_2$ were fired to cones 05a-5a. (1) No crystals appeared in glazes with PbO less than 0.70 equiv. (2) The crystals can be obtained with glazes which contain less than 0.20 equiv. of Al_2O_3 and more than 0.5 equiv. of SiO_2. S. K.

English slipware. C. LOUISE AVERY. *Bull. Met. Mus. Art*, pp. 46-48. Feb. (1925).—The Museum has recently acquired 5 splendid examples of the picturesque and characteristic slipwares of the 17th and 18th centuries which constitute so important a chapter in the history of English pottery. THOMAS TOFT was the outstanding personality among the potters of that time, presumably working in Staffordshire. These 5 pieces are very fine examples of Staffordshire and Devonshire ware. A. A. A.

Recent classical accessions. G. M. A. RICHTER. *Bull. Met. Mus. Art*, pp. 48-50. Feb. (1925).—The Museum has recently acquired 9 Greek vases made especially for funeral purposes, some of which show representations of mourners at the grave. One vase depicts the crossing to the realm of the dead in Charon's boat. On these vases the start of the journey is always shown and never the arrival on the other side. The fragments of one of the pieces are warped showing that they were thrown into the funeral pyre after they had served their original purpose. A. A. A.

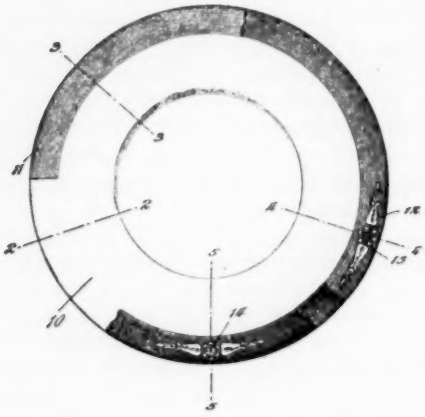
Athenian red-figured vases. G. M. A. RICHTER. *Bull. Met. Mus. Art*, pp. 128-32. May (1925).—An account of the showing of 42 red-figured vases which have been acquired in recent yrs. and lately shipped to this country. There are a number of rare and interesting subjects represented in this exceptional group. One of the most important pieces is a large kylix by Douris showing 2 women putting away their clothes. A bell krater with lug handles; a large Hydria decorated with a representation of the baby Herakles strangling the serpents; a small Hydria, Poseidon welcoming Thesus; and a small kylix, boy playing the lyre, are among the most interesting. There are three vases with no figured representation but they are distinguished by their fine form and good preservation. Three are molded vases shaped in the forms of the head of a woman, a lobster claw, and the head of a satyr. Two small amphoræ with single figures are Etruscan copies of the Athenian ware and are quite a bit different. The details are incised instead of painted and the line is not as interesting as in the Greek examples. A. A. A.

Early terra cotta sculptures and vases. G. M. A. RICHTER. *Bull Met. Mus. Art*, Jan. (1925).—Six important pieces of sculpture in terra cotta recently acquired by the Museum show the Greek sculptor at work during the 6th and 5th centuries B.C. They consist of both architectural pieces and fragments of statues. The 3 early vases recently acquired date from the geometric period of the 9th and 8th centuries B.C. The ware is in the early Italic style untouched by later Greek influence. A. A. A.

Recent accessions in the Near Eastern collection. M. S. DIMAND. *Bull. Met. Mus. Art*, **20** [10],237-39 (1925).—Four new specimens of Persian and Syrian pottery have just been acquired by the Museum. The examples of Persian pottery represent rare new types belonging to the early Mohammedan period. The color decoration of one of these bowls is Persian while the design is Chinese in character. This piece seems to be of the same date as the Sino-Iranian group of Persian pottery in which the color decoration and design are derived from the Chinese pottery of the T'ang period (618-906). A second bowl belonging to the 9th or 10th century, is another type of early Persian ceramics and the design is quite unusual. A plate is decorated in brown and cobalt blue over a white engobe and covered with a creamy glaze. Although said to have been found at Veramin in Persia, in design and color decoration this plate is related to a group of pottery known as Syrian and assigned to 14th century. The 4th piece shows the characteristics of the 14th century decoration and is probably of Syrian origin. It was found at Sultanabad. The center is decorated with a balanced design of 2 hares in cobalt blue amid the branches of tall plants in olive green with leaves in cobalt blue, turquoise, and purple manganese. In the border are rosettes and Arabic inscriptions. The outside has an Arabic inscription in relief on a cobalt blue background. Below are conventionalized palmettes. A creamy transparent glaze covers the whole bowl. A. A. A.

PATENTS

Process for the metallization of porcelain or glass. ALPHONSE FLORENT EIJSSEN, U. S. 1, 558, 853, Oct. 27, 1925. A process for metallizing a dull surface of nonconducting-hard mat. comprising rubbing the surface with a very small quantity of a viscous polyvalent alcohol by means of a metal brush and then depositing electrolytically a further metal coating.



Ornamental glassware and method of making the same. JACOB BASS, U. S. 1,561,397, Nov. 10, 1925. The method of mounting glass jewels, or the like, on an article of glassware, which comprises, electroplating a layer of metal into the glass, soldering a metallic object having a jewel recess, onto the layer of metal, electroplating the object and layer to conceal the solder, and fastening the jewel into the recess.

Cement, Lime and Plaster

Results of the experiments on the second proposed natural standard sand. M. KOMURO, S. KANO, H. HORIE AND S. INOKUCHI. Comm. of Stand. Sand. Jap. Assn. of the Port. Cement Engineers. *Rept.* **16** [2], 23 (1924).—The Comm. proposes to revise the clause on the stand. sand in the Jap. Port. Cement Specif. as follows: "Natural quartz-sand, produced in Soma-gun, Fukushima Prefecture, is treated in a ball mill so as to grind its accessory minerals, washed and dried. The portion which passes through No. 1 sieve (64-mesh sq. cm., wire 0.4 mm. thick) and remains on No. 2 sieve (144 mesh sq. cm., wire 0.3 mm. thick) is used as the stand. sand." The sand and cement mortars with it were tested at labs. of 31 plants.

TABLE I.

NATURE OF SANDS

	Fineness		Wt. of 1 l.	Void	Sp. gr.
	64-144	144-225	in g.	%	
Stand. coarse sand	96.70	1.50	1400	46.08	2.624
Stand. fine sand	5.29	90.97	1384	46.42	2.632
Proposed stand. sand	96.55	0.39	1626	39.99	2.642

1 g. of sample contains

Quartz sand		Impurities		Brown quartz sand	
No. of grains	Wt. in g.	No. of grains	Wt. in g.	No. of grains	Wt. in g.
1396	0.9549	21	0.0198	34	0.0459
3278	0.9660	34	0.0104	60	0.0126
929	0.9694	14	0.0168	16	0.0206

Chem. compn. (Stand. sand now in use is mixt. of the coarse and fine sands in equal parts)

Ign. loss	Insoly.	ratio SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Total
0.25	0.43	97.59	1.10	0.71	0.60	0.17	0.35	99.94
0.27	1.00	97.16	0.83	0.62	0.54	0.21	0.26	99.83

TABLE II

STRENGTH OF A PORTLAND CEMENT

	Tensile strength. kg/sq.cm.				Crushing strength. kg/sq. cm.			
	Water %	1w.	4w.	3m.	Water %	1w.	4w.	3m.
Neat cement	14.3	61.8	66.2	69.3	....	....	....	....
Stand. sand (1:3 mortar)	7.3	20.8	26.5	32.8	7.4	132	199	267
Proposed sand (1:3 mortar)	6.7	23.3	29.9	37.4	6.5	236	338	433
Strength of the proposed sand in per cent of the stand. sand	....	112.7	111.8	116.4	....	194.0	180.0	166.3

S. K.

On the revision of the Japanese Portland Cement Specifications. KEISUKE SHIODA AND SHIMPEI KAJIWARA. Comm. of cement specif. Jap. Assn. of the Port. Cement Engineers. *Rept.* **16** [5], 21 (1924).—Revision of the Jap. Port. Cement Specif. proposed by the Comm. is described. S. K.

Technical analysis of SO_3 in Portland cement. FUMIO SUZUKI. *Jour. Jap. Ceram. Assn.* **32** [380], 342-43 (1924).—S. proposes a new method of detg. SO_3 in Port. cement very quickly. S. K.

Theory and practice of lime manufacturing.—I. I. VICTOR J. AZBE. *Rock Products*, **28** [13], 45-46 (1925), Pt. I.—Heat distribution in a theoretical lime kiln, kiln efficiency rating, amt. of ht. required. The formula for efficiency of a lime kiln is developed.

$$100\frac{1378C+977M}{H} = E$$

C = No. of lbs. of CaO per lb. of coal
M = No. of lbs. of MgO per lb. of coal
H = Ht. value (B.t.u) per lb. of coal
E = Thermal kiln efficiency

Ibid. **14,** 38-9, Pt. II.—The effect of excess air on the lime kiln efficiency. Excess air used in combustion of fuel in lime kilns is far more serious than in boiler practice. *Ibid.* **15,** 39-40, Pt. III.—Incomplete combustion and loss by radiation. The important sources of fuel loss other than excess air, namely, incomplete combustion and radiation are discussed. *Ibid.* **16,** 39-41, Pt. IV.—Judging kiln performance by gas anal. Kiln "thermal" efficiency and ratio of fuel to lime are taken up. *Ibid.* **17,** 52-3, Pt. V.—Reduction of kiln efficiency during drawing, reversed circulation. Lime kiln ht. transfer is discussed. Condy. of charge, flame luminosity, and gas velocity, are factors affecting ht. transfer. *Ibid.* **19,** 53-4, Pt. VI.—Kiln capacity, rating, proper kiln propn., and some operating data on some test kilns. A kiln must be so proportioned that a charge of lime will travel through the kiln at the proper rate, and that the gases will not leave the kiln in too short a time for them to have a chance to give up their heat to the charge. Data on test kilns are given. *Ibid.* **20,** 58-60, Pt. VII.—Relative methods of kiln firing. The methods of firing include oil, gas, stoker and direct. The most inefficient is the direct-hand fired. The automatic stoker method is very promising. Refractories and the factors controlling their life are taken up. *Ibid.* **21,** 42-1, Pt. VIII.—General inefficiency of lime mfg. and conclusions. Thermal fuel efficiency as low as 25% is common. Efficiency as high as 50% is not common. Under proper conditions efficiencies in the neighborhood of 60% should be realized. Lack of a standard

of comparison of data is largely responsible for the lack of knowledge on lime burning. Technical information leading to fuel efficiency, kiln capacity, longer kiln running periods, and better lime should be obtained. H. G. F.

Some possible commercial uses for gypsum other than plaster. ANON. *Rock Products*, **28** [19], 50-52 (1925). The effect of gases at high temps. on gypsum is shown. CaO, $CaCl_2$, CaS_2, may be prepd. with different percentage yields depending upon temp., gas, and catalyzer used. H. G. F.

Tunnel kiln proposed for lime manufacturing. CHAS M. PEASE. *Rock Products*, **28** [20], 61-64 (1925).—The unexpected success of tunnel kilns in practically every branch of the ceramic indus. has made serious consideration of the tunnel kiln for the lime industry worth while. The proposed kiln will consist of 6 zones, entrance chamber, exhaust zone, preheating zone, firing zone, slow cooling zone, and rapid cooling zone. Even temp. distribution in the zones is assured. It is thought that this method will make possible the complete burning of fine material as well as coarse. Tests of lime burning in ceramic kilns have been made which bring out a number of new features to be applied to the lime industry. H. G. F.

Calcium sulphate retarders for Portland cement. ERNEST E. BERGER. *Rock Products*, **28** [22], 56-59 (1925).—Abs. from U. S. Bur. Mines, Tech. Investigations, **2705**. H. G. F.

Recent work of the lime, gypsum and sand-lime brick sections of the Bureau of Standards. ANON. *Rock Products*, **28** [22], 60-65 (1925).—The following investigations are being conducted between the Bur. and industries, coöperatively. I. Problems relating to lime, (*a*) Improvement of the plasticity of hydrated lime. Ten samples of varying compn. from dolomite to high calcium stone, from different localities are being investigated. (*b*) Lime for use in the mfg. of bleaching powder. Definite amts. of pure quicklime were added to definite amts. of water. After anal. the hydrates were subjected to the action of chlorine. In 30 days the available chlorine was detd. and it was found that a satisfactory bleaching powder could be obtained with from 32 to 55% water (by wt.). The best results were with hydrates of from 45 to 50% water. (*c*) The sand carrying capacity of quicklime. Results showed that a lime mortar should not be richer than 20% quicklime (by wt.) nor leaner than 10%; 15% was found to give the best results. (*d*) Quicksetting and hydraulic lime. Results indicate that a quicksetting lime can be produced by calcining limestone relatively high in silica and alumina. (*e*) The anal. of lime plaster. Chem. anal. fails to show the condition of combination of the magnesia content of mortar. Thermochem. methods of anal. are being investigated with promise. (*f*) The manuf. of lime. Bur. of Standards Tech. Paper No. 16 is being revised. II. Problems relating to gypsum. (*a*) The weatherproofing of gypsum. Three methods have been attacked, (1) coating the surface with waxes of paraffines, (2) pptg. an insol. compd. on the surface, (3) adding an integral weatherproofing compd. to the gypsum. The first 2 methods give promise. (*b*) Ready-sanded gypsum plaster. Various mixts. of plaster contg. clay, hydrated lime, asbestos, wood fiber, hair and talc and different amts. of gypsum plaster are being tested for strength, vol., water required, and working quality. (*c*) The effect of age of calcined gypsum on the linear expansion of the set plaster. On exposure there is a gradual hydration of calcined gypsum. The percentage of water required to bring mortars to normal consistency was less with aged samples of calcined gypsum. For any particular sample of calcined gypsum, a loss in percentage of calcined gypsum causes the plaster to expand or contract more when exposed to humidity changes. (*d*) The cause of the acceleration in time of the set of machine mixed plasters. This effect was found to be due to the presence of previously set small quantities of gypsum in the mixer. (*e*) The calcination of gypsum. Results indicate the desirability

of trying out different methods of calcination in the plant. (*f*) Strength of bond between gypsum plaster and various backings. Expts. indicate that there is a great difference in values for adhesion of gypsum plaster to different kinds of backings. (*g*) Manufacture of gypsum products. A manuscript for the publication of a technological paper has been prepd. III. Problems relating to both lime and gypsum. (*a*) The elasticity of plasters, and the rate of drying wall plaster have been investigated. IV. Problems relating to sand-lime brick. The bond of mortar to sand-lime brick. Best results were obtained when 13% water was present in the brick. A bibliography is included in the report. H. G. F.

Cause of disintegration of concrete. ALFRED H. WHITE. *The Canadian Engineer*, **49** [14], 439-41 (1925).—Portland cement is a chem. product, and the causes of its disintegration are due largely to chem. reactions. The chief constituents are silicates and aluminates of lime, which combine with water to form interlocking cryst. compds. Cement kept under water expands at a decreasing rate up to 0.162% in 15 yrs. Contraction occurs in air at a greater initial rate, and to 2 or 3 times the amt. in 15 yrs. Cracking due to shrinkage may be prevented by the use of a lean mixt., strong steel reinforcements, and the use of concrete in small blocks. Secondary causes of disintegration are (1) temp. changes, (2) frost, and (3) corrosion of steel reinforcement. Variation of moisture content due to weather conditions is the most important cause of disintegration, while frost is relatively unimportant. E. E. P.

Regarding volume increase and water intake of hydraulic binding agents with respect to density and strength. WOLFGANG KALK. *Zement*, **14**, 593-97 (1925).—Porosity of the cement depends upon the degree and kind of grinding and therefore it has influence upon density and strength of the binding agent. The hardening takes place under an increase in volume of the granules of the cement, while the absorptive binding processes of the colloidal parts are opposing these appearances. W. S.

Regarding the work in the "Vereins" laboratory in 1924. G. HAEGERMANN. *Zement*, **14**, 560-62, 573-75 (1925).—Maxima, middle and minima values of the tests on German Port. cements and high grade Port. cements. Also a description of the other research work done by this Inst. W. S.

Advantages of thorough mixing of raw cement. O. FREY. *Zement*, **14**, 422-24 (1925).—By an entire uniformity of the raw flour a considerably higher mech. strength of the cement is obtained, also advantages for the process of firing. W. S.

Regarding hardening of concrete at low temperatures above the freezing point. A. GESSNER. *Beton u. Eisen*, **24**, 161-62 (1925).—By tests on test pieces made of concrete it was found that high grade cement also loses in velocity of hardening when the binding and hardening takes place at temps. a little above the f. p. Due to its rapid hardening in the beginning, however, it still reaches a strength which lies above the values of regular Port. cement which hardened at temps. of 10 - 20°C. W. S.

Cement for potter's plaster-of-Paris. ANON. *Oil and Colour Trades Jour.*, **68**, 621 (1925).—Take one-half lb. of best Scotch glue and lay it in water to cover for about 12 hrs. Without any water, warm until melted, then add, a little at a time, some zinc white powder until it becomes like cream. When wanted for use, warm up, and apply it the same way as you would for cementing china. If it gets too thick, add a little water. O. P. R. O.

Magnesia as a ceramic raw material. A. BERGE. *Kali* **19**, 285-8 (1925).—Applications are discussed and some expts. reported. In MgO cements increasing the $MgCl_2$ retards setting; with (mol. ratio $MgO/MgCl_2.6H_2O$) a 1/1 mixt., the setting time

was 21 days, with 2/1, 8 days, with 4/1, 3 days. Cements were prepd. by using 2 parts by wt. of MgO and 1 part of each of various chlorides. With $CaCl_2$, $BaCl_2$, $SrCl_2$, $ZnCl_2$, $HgCl_2$, $MnCl_2$ and $CuCl_2$ the reaction was similar to that with $MgCl_2$ as regards rate of setting and character of product, save that in the last 2 cases the products were, resp., brown and blue. With $AlCl_3$ or $FeCl_3$ the setting was almost instantaneous, while no reaction occurred with $PbCl_2$. Samples of MgO prepd. from the oxychloride or from magnesite at 600, 1200, or 1600° all reacted the same with $MgCl_2$ within the limits of observation. Cements prepd. from MgO with $AlCl_3$ or $FeCl_3$ were least resistant to the action of H_2O; those from $CuCl_2$, $MnCl_2$, or $SnCl_2$ were the most resistant. In general cements with more than 1 mol. chloride to 4 mols. MgO were not resistant to H_2O. (*C. A.*)

PATENTS

Cement kilns. ANON. Brit. Pat. 238, 407. *Quarry and Surveyors' and Contractors' Jour.*, **30**, 305 (1925).—The invention comprises the treatment of the fire-brick surfaces to facilitate the formation on the brick of a protective covering of cement clinker. In one manner of carrying the invention into effect, the brick surfaces are roughened, scoured or indented to increase the normal tendency of the cement clinker to adhere and form a protective coating. Alternatively the brick surfaces are impregnated with cement clinker in the process of manuf., particles of clinker of suitable size being embedded in the brick surfaces to a suitable depth. When put into use, the coating readily combines with a further quantity of clinker. O. P. R. O.

Method of making anhydrous magnesium chlorides. PAUL COTTRINGER and WILLIAM R. COLLINGS. U.S. 1,557,660, Oct. 20, 1925. In a method of making anhydrous magnesium chloride, the steps which consist in intermixing partially dehydrated magnesium chloride with the normal hydrated salt, both in solid form, and then directly htg. the mixt. at a temp. sufficiently elevated to drive off water of crystn. In a method of making anhydrous magnesium chloride the steps which consist in driving off a portion of the water of crystn. from the normal hydrated salt by moving the latter in opposed direction against a current of gases of combustion, regulating the temp. of such gases by admixing air at normal temp. therewith, and returning a portion of the product for use over again in the preceding steps.

Method of making cement. ANDREW GILBERT CROLL. U. S. 1,562,207, Nov. 17, 1925. The method of making Port. cement whereby the strength of the resulting product is substantially increased, which comprises firing the ingredients at a clinkering temp. quenching the clinker at white ht. and grinding the same.

Enamel

How Na and Fl affect enamel fusion. Translated by WALTER SCHULTZ. *Ceram. Indus.*, **5** [4], 346 and 348 (1925).—The influence of the opacifiers, fluorspar, cryolite and sodium silico-fluoride, on the fusing points of enamels were studied. The following commercial batches of enamel, without addition of zinc oxide and clay, were made up:

I	Per cent	II	Per cent
Quartz	19.1	Feldspar	28.2
Boric acid	4.3	Quartz	20.3
Borax	34.4	Borax	38.8
Feldspar	34.6	Soda Ash	10.2
Aluminum Oxide	3.2	Cryolite	2.2
Fluorspar	3.5		

III

Feldspar	28.9	Soda Ash	5.3
Aluminum Oxide	2.6	Niter Cake	13.2
Quartz	12.0	Sodium Silico-fluoride	3.0
Borax	34.9		

The effect of varying the fluorspar, at the expense of the other ingredients, from 3.5 to 72% was studied, using batch I. The results show that fluorspar is considered a flux up to 4%, a non-flux from 4 to 25% and a flux from 25 to 50%. At higher percentages it approaches its own fusion point. Calcium and silica mixts. gave similar results. A second sines, in which the quartz content of batch I was increased and the feldspar reduced approx. 66⅔% was subjected to a variation in fluorspar content. Fluorspar acted as a flux up to 5%, as a non-flux from 5 to not over 18% and as a flux up to 45%. A third trial was made, using batch II, increasing the content of cryolite from 2.2 to 62%. Up to 20% cryolite acted as a strong flux and lowered the fusion point of the enamel from 950°C to 820°C. A fourth trial was made, using batch III, in which the sodium silico-fluoride was increased. As seen by the curve, there was a gradual increase in fusion points, with increase in sodium silico-fluoride. P. D. H.

How to obtain an enamel to suit your purpose. RUDOLPH WEIMER. *Ceram. Indus.*, 5 [4], 350 (1925).—This article contains methods used by FROELICH, the eminent German enameler. W. compares enamel compns. to Jena glass. The enamel compns. are divided into refrac. and fluxes. It is shown within what limits the compn. of the Jena glass may be varied, in order to obtain ground coats and cover coats without altering the expansion coeff. P. D. H.

How you can fit any cover coat to a ground coat. RUDOLPH WEIMER. *Ceram. Indus.*, 5 [5], 425-26 (1925).—W. gives extensive tables made up by R. FROELICH, showing the compn. of ground and cover enamels in which the ingredients have been so adjusted that the coeff. of expansion between the sheet steel or iron and the ground coat and between the ground coat and the cover coat have been brought into close harmony with each other. An explanation of the variations of the ingredients is given. P. D. H.

Identity of temper carbon and iron graphite. A. LISSNER and R. HORNY. *Stahl u. Eisen*, **45**, 1297-1301 (1925); *Jour. Soc. Chem. Ind.*, **44**B, 72 (1925).—The conclusion is drawn from the chem. behavior of graphite from gray iron and temper carbon pptd. during annealing of white iron, that the two forms of C are identical. Owing to its more finely divided condition, the temper C ignites at a lower temp., but both have the same heat of combustion, both yield the same graphitic acid, and both resist the action of HNO_3, H_2SO_4, and fused $NaHSO_4$. H. H. S.

Hardness of chill cast iron. P. GOERENS and H. JUNGBLUTH. *Stahl u. Eisen*, **45**, 1110-1117 (1925); *Jour. Soc. Chem. Ind.*, **44**B, 673 (1925).—The shore hardness number of chill-cast iron increases in direct propn. to C content from 56 to 2.4% C to 84 at 4.2%, Si constant. The thickness of the hard outer layer varies considerably with the rate of cooling and Si content. In general, the thicker the walls of the mold, *i.e.* the greater the cooling on pouring, the thicker is the hard layer; and the larger the Si content, the thinner the hard layer. With 0.3% Si, the thickness is 60 mm; with 0.8% Si, 15 mm; with 1.1–1.4% Si, 0.8–0.6 mm. Mn between 0.25 and 0.6%, and S between 0.17 and 0.068% have no influence on the hardness. H. H. S.

Shrinkage of cast iron. E. SCHÜZ. *Stahl u. Eisen*, **45**, 1189-95 (1925); *Jour. Soc. Chem. Ind.*, **44**B, 721 (1925).—White-heart cast iron contracted 1.93%, and black-heart cast iron 1.89%. Thin-walled castings shrank somewhat more, and thick-walled castings somewhat less. The white-heart had the greater C content. The effect of Si up to 3.3%

is negligible on the shrinkage of pearlitic and hyper-pearlitic cast iron. In annealing, shrinkage is less the more temper carbon the casting contains, and greater the more the casting is decarburized. It may be artificially influenced by long or short annealing according to wall thickness. Annealed thin-walled white-heart shrank 2%, thick-walled white heart and thin-walled black heart 1.5%, and thick-walled black-heart 1%.

H. H. S.

Differentiation of iron and steel. A. SAUVEUR. *Rev. Mét.*, **22,** 355-56 (1925); *Jour. Soc. Chem. Ind.*, **44B,** 635 (1925).—Iron and steel are sharply marked by their respective C and Mn contents. Commercial iron is defined as the element iron as pure as it may be obtained commercially. Ingot iron is commercial iron produced in a liquid state and cooled. Forged iron is a malleable ferrous metal produced from a plastic condition.

H. H. S.

Shrinkage in white and gray iron. P. BARDENHEUER and C. EBBEFELD. *Stahl u. Eisen,* **45,** 825-34, 1022-27 (1925); *Jour. Soc. Chem. Ind.*, **44B,** 634 (1925).—WÜST's app. was modified to eliminate errors due to htg. of the shrinkage transmission wires. The initial expansion of iron on solidification is closely associated with the gas content of the iron, and is caused by the sudden drop in soly. of the gases at the solidification point. Shrinkage of gray iron is less than that of white iron, the difference occurring chiefly in the pre-pearlitic period, in which secondary graphite is deposited. The post-pearlitic shrinkage is approx. the same in each case. Alloying elements affect shrinkage by their influence on the secondary graphite deposition; an element which assists deposition causes less pre-pearlitic, and therefore less total, shrinkage. Si diminishes, Mn and S increase, shrinkage. P up to 3% does not influence cast iron shrinkage; it prolongs the solidification interval. By heating the mold the pre-pearlitic shrinkage may be reduced to nil, a practice of value in preventing strains and cracking of castings. The hardness and tensile strength of the iron are diminished by this process, but the bending strength is not affected.

H. H. S.

Inner crystalline structure of ferrite and cementite in pearlite. N. T. BELAIEW. *Proc. Roy. Soc.*. **A108,** 295-306 (1925); *Jour. Soc. Chem. Ind.*, **44B,** 635 (1925).—Cementite lamellae, under magnification 4000, are petal-like in shape and curvature, but the edge is usually composed of rectangular steps, which are of uniform size, and point to the conclusion that cleavage occurs through a definite line or unit. Ferrite lamellae show small isolated cubes, the edge of the cube being about 250$\mu\mu$; their dimensions are about the same in alloys of different C content. It is suggested that every ferrite lamella is built up of such cubes, suitably oriented. Every pearlite grain has been subject to stress by the change of iron from face-centered to cube-centered lattice. These stresses give the cementite lamellae their curved form, and split the ferrite lamellae into a multitude of cubes.

H. H. S.

Effect of temperature and chemical composition on viscosity of iron. P. OBERHOFFER AND A. WIMMER. *Stahl u. Eisen,* **45,** 969-79 (1925); *Jour. Soc. Chem. Ind.*, **44B,** 634 (1925).—Viscosity was measured by the logarithmic decrement of a pendulum swinging in the molten iron. A sudden increase in viscosity is observed in pure Fe-C alloys at 1335° for 2.62% C, and 1180° for 3.43% C; this corresponds with the sepn. of mixed crystals. P increases viscosity but lowers the initial solidifying point, which accounts for the apparently increased fluidity in practice. MnS increases viscosity considerably, and C and Si also increase it.

H. H. S.

Dilatometric analysis of cast iron. P. CHEVENARD AND A. PORTEVIN. *Rev. Mét.*, **22,** 357-73 (1925); *Jour. Soc. Chem. Ind.*, **44B,** 634 (1924).—Determinations were made by differential dilatometer over the range 0°–1100° using the Ni-Cr-W alloy Pyros as standard. Swedish iron showed a marked change in dilatation coeff. in the region of the

magnetic transformation (770°), and a sharp contraction during the α-γ transformation, this contraction being less as the impurities in the iron increased. Cementite, isolated, showed a reversed change in dilatation value, coinciding with the magnetic transference point; a similar point of inflexion was indicated by all ferro-magnetic alloys, such as α iron, magnetite, and ferro-metals. It is considered that the term "double carbide" should be replaced by "cementite complex," as it has been proved that Mn_3C forms a solid soln. with Fe_3C. H. H. S.

Oxygen in iron. P. OBERHOFFER. *Stahl u. Eisen*, **45,** 1341-48, 1379-84 (1925); *Jour. Soc. Chem. Ind.*, **44B,** 763 (1925).—Nine synthetic irons and 14 steels were examd. for O by the hydrogen, heat extraction, and bromine processes. The last 2 methods enable the changes in form of the O compds., after various metallurgical treatments, to be shown. A greater O content was found in acid than in basic open-hearth steel. High O content was associated with flaky fracture of a saw steel, and red shortness of a Ni-Cr steel. Photomicrographs are given showing the effect of O in balling-up the cementite network of iron, the coarsening of structure of annealed eutectic steel, and the formation of troostite spots on quenching. A steel low in O showed a higher impact resistance, but a greater temper brittleness, than steel high in O. H. H. S.

Allotropy of iron. F. WEVER. *Stahl u. Eisen*, **45,** 1208-10 (1925); *Jour. Soc. Chem. Ind.*, **44B,** 721 (1925).—Elements alloying with iron may be divided into 2 classes: Those that increase the stability of the face-centered γ lattice, such as C, Ni, and Mn, and those that increase the stability of the space-centered α phase, such as Sn, Si, W, and Mo. WESTGREN established by X-rays that there are only two polymorphic phases of iron, the cubic space-centered lattice below 900° and above 1400°, and the cubic face-centered lattice between 900° and 1400°. H. H. S.

Corrosion relations at different temperatures of iron and steel alloys which have been known up to the present time as non-rusting. ALFRED BRUNNER. *Vierteljahrsschr. naturforsch. Ges. Zurich* **69,** Beiblatt No. **6,** 1-79 (1924); *Chem. Zentr.* **1925,** I, 1797-98.—A study of the action of chem. reagents on various types of steel at room temp., at 60-80°, and at 400°. The most important fact detd. was that the greatest resistance to corrosion is possessed by highly alloyed steels contg. 4 components. Furthermore Cr steels with at least 11% Cr and a low C content (below 0.2%) are practically as resistant. With increase in the %Cr or with the introduction of Ni the resistance increases still more. In contrast to the Cr steels, pure Ni steels are easily attacked. Spring water, SO_2, dil. HNO_3 and org. acids such as HOAc, malic, citric and lactic acids attack Ni steels more readily than Cr steels. Krupp V2A steel was the only one found which was resistant to org. acids and to SO_2. Ni steels are more resistant to H_2SO_4. No definite relations could be detd., for the individual types of steels showed great variations which could not be correlated with their compn. At boiling temp. they often are easily corroded if air is brought in contact with the surface simultaneously with treatment with salt or acid solns. Contact expts. involving Cr-Fe and Cr-Ni-Fe alloys in salt solns. with ordinary steels showed that the former are resistant to corrosion at the expense of the latter. For proof against rusting it is important that there be heat treatment before or after working. Small variations may greatly impair the resistance to rusting, and furthermore polishing is of importance. The resistance to rusting decreases when the alloy becomes tarnished. Technical applications of non-rusting steels and highly alloyed Si-castings included machines and equipment which are exposed to high temps. and where there is no possibility of condensation on the polished surface. If the latter is the case, then such alloys can be exposed even to strongly acid vapors. If they condense on the surface, however, only Krupp V2A steel is suitable. With the exception of V2A steel, it is important whether const. or periodic exposure to chemicals is involved. (*C. A.*)

Rust-resisting steel V2A, and apparatus constructed thereof. B. STRAUSS. *Krupp Monatsh.* **6,** 149-57 (1925).—This steel contains 20% Cr, 7% Ni and 0.2% C, photomicrographic examn. showing a mixed crystal-austenite structure in which C, Cr and Ni are completely dissolved. V2A not only possesses good mech. strength, 70–80 kg. per sq. mm., 50% elongation, but is very inert to chem. action. The wt. in g. per hr. per sq. mm. of metal dissolved in various reagents at temps. from 20° to 150° is as follows: HNO_3 concd. at 20° 0.00 g., boiling 0.02 g.; HNO_3+5% H_2SO_4 boiling 0.59 g.; H_2SO_4 at 20°, 10% 0.07 g., 30% 0.16 g., 66% 0.001 g., 98% 0.012 g., 20% boiling 36.0 g.; 58% H_2SO_4+40% HNO_3+2% H_2O at 20° −0.00 g., at 60° 0.05 g., at 100° 0.70 g., 110° 7.6 g.; 80% H_3PO_4 at 115° 134.3 g.; 50% KOH soln. boiling 0.40 g.; KOH at 360° 3.5 g.; at 600° 37.9 g.; $CuCl_2$ soln. boiling 1–1 464.0 g.; $FeCl_3$ soln. 1–1 101.0 g. at 50°; other salts and acids, only slight action. V2A has a *sp. gr.* 7.86, *sp. heat* 0.118, *thermal condy.* 0.04, *coeff. of expansion,* 0–100° 16×10^{-6}, 0–600° 18×10^{-6}, 0–1000° 20×10^{-6}, *m. p.* 1400°. This steel permits of autogenous welding and can be cold-drawn, or stamped, permitting its use in the manuf. of many types of equipment, photographs of which are shown. Special heat treatment is needed, the temp. being raised to 1170° and the alloy then quickly cooled. For acids which attack V2A, 2 special alloys are made, V4A and V6A, contg. Mo and Cu. V2A also finds application in the canning industry. (*C. A.*)

The temperature distribution in free reflecting glowing iron blocks. HANS SCHMICK *Z. tech. Physik* **6,** 365-70 (1925); 9 cuts.—The temp. distribution in cylindrical Fe blocks has been calcd. for the first minutes after the beginning of cooling and for an initial temp. of 1200°. The temp. of the surface so ascertained is connected with the mean temp. of the block. The difference between these temps. is considerable with blocks of large diam., since the cooling progresses only very slowly toward the interior of the block. The expts. herein reported on Fe rods of 3 cm. diam. are of the order of magnitude of those calcd. (*C. A.*)

"Armco" iron. ALBERT SAUVEUR. *Rev. métal.,* **22,** 397-99 (1925).—Brief outline of the process of manuf. and properties. (*C. A.*)

Stainless or rustless iron correctly described as stable-surface iron. P. A. E. ARMSTRONG. *Trans. Am. Soc. Steel Treating,* **8,** 163-87 (1925).—Rustless Fe is not entirely resistant to surface corrosion. The film-forming characteristic that protects these alloys from serious corrosion is also the cause of discoloration. They are only stainless when conditions are favorable; such conditions are, however, quite destructive to ordinary Fe and often to non-ferrous metals. Rustless iron must be produced free from included dirt, otherwise pitting will readily take place. A pickled surface on rustless Fe is quite as good as a polished surface and less costly. Bronzes do not always cause rustless Fe to corrode in the presence of an electrolyte, and care should be exercised to obtain a suitable bronze metal for bearing applications. Auto-electrolysis plays an important part. Cooking utensils are not free from danger. Rustless Fe seems to be without harmful effect. Phys. properties of rustless Fe will bear careful scrutiny; they can be improved by the use of alloys. Ni does not appear to raise the propl. limit. (*C. A.*)

Foundations for heat-treating commercial alloy steels. F. W. DUESING. *Mitt. Kaiser-Wilhelm Inst. Eisenf.,* **6,** 71-135 (1925).—For a number of construction steels, contg., resp., Mn, Mn-Si, Ni, Cr-Ni and Cr as alloying elements, D. investigated the transition phenomena in the critical range. Both the thermal analysis method and the detn. of the hardness as a function of the quenching temp. were used. For a proper heat treatment the knowledge of the Ac_3 point is indispensable. This point cannot be properly located on the heating curve. On the other hand the quench temp.-hardness curve gives reliable results. Mechanical tests made on a Cr-Ni steel confirmed the results of the quench-hardness method. The effect of annealing (heating of test bars

for 90 min. at temps. ranging from 600-1000°, followed by cooling for 48 hrs. in ashes) on the mechanical properties led to the conclusion that a little below Ac_1 the steels were in their softest condition. Photomicrographs of steels thus annealed showed the cementite to be spheroidized. A considerable amt. of work was done on the effect of different methods of quenching and tempering on the mechanical properties and microstructure of the above-mentioned alloy steels. The results are represented in numerous tables, cuts and photomicrographs (at 500 diams.). Dynamic tensile tests by the method of Koerber and Simonson showed that invariably more energy is required to break the specimens than in the ordinary static tensile test machines. The article is concluded by a comparative study of the relation between (1) Brinell hardness, (2) Shore hardness, (3) Wuest-Bardenheuer hardness and (4) tensile strength. (*C. A.*)

The dilatation of cast irons during repeated heating and cooling. J. H. ANDREW AND ROBT. HIGGINS. *Jour. Iron Steel Inst.*, **1925,** (preprint, 24 pp.). (*C. A.*)

PATENT

Method of and apparatus for loading and unloading enameling furnaces. ROBERT A. WEAVER. U. S. 1,559,591, Nov. 3, 1925. In app. for loading and unloading enameling furs., the combination of a charging fork adapted to be moved into and out of the fur. to load and unload the fur., and a transfer table adapted to be loaded with the work to be deposited in the fur., said transfer table being adapted to be moved transversely across the path of movement of said charging fork, said charging fork being adapted to carry suitable racks for supporting the work in the fur., and said transfer table being adapted to support the load directly over said racks carried by said charging fork, said charging fork being adapted to be raised and to thereby lift the work from said transfer table to said racks on said charging fork, and said transfer table being adapted to be removed out of its position in the path of the charging fork.

Glass

250,000,000 bottles made annually in English plant. JACK BROOKS. *Ceram. Indus.*, 5 [4] 311-13 (1925).—A description of the Charlton plant of the United Glass Bottle Manufacturing Co., Ltd., England, is given. The sand used comes from the local pit for common products and from Belgium and Fontainbleu for fine products. Raw mats. are put into containers, ground, passed through mixers and dropped into furs. Owens automatic bottle machines are used. The furs. are fired with oil. "Torpedo" continuous tank furs. give increased efficiency. P. D. H.

Conveyors cut cullet crushing cost. ANON. *Ceram. Indus.*, **5** [4], 316-17 (1925).—Bucket conveyors at the Maryland Glass Corporation plant in Boston hoist the rough cullet into a roll crusher. From the crusher the glass drops over an electro-magnet onto a soft rubber belt conveyor and is carried into inclined bins which are filled with water in the lower end. The crushed glass is removed from the tanks by continuous screw conveyors onto a rubber conveyor belt which carries it to containers placed on elec. trucks. The crushed cullet is stored in bins. P. D. H.

Practical application methods of metallic iridescent lusters on glass. ANON. *Ceram. Indus.*, **5** [4], 318-19 (1925).—Metallic silver has a good covering and light reflecting power, if it is heated very carefully between the limits of 644° to 896°F. For metal lusters, 1.5 to 3.0% of metallic silver is sufficient in a soln. of silver resinate mixed with bismuth resinate. A mixt. for a glass, varying in appearance between silver and platinum, is 15 parts bismuth resinate, 100 parts silver soln. (3.4%) and 4 parts soln. of boric acid in benzyl alcohol. The mixt. is applied at a temp. of 690° to 720°F. When pure solns. of

gold-and-silver-sulphur resinate are mixed in essential oils, silver glass predominates. The mixts. fire at the following ratios:

(1) 1 part gold: 1 part silver = silver white.
(2) 3 parts gold: 1 part silver = yellowish white.
(3) 6 parts gold: 1 part silver = light yellow.

6 parts gold, 1 part silver and 4–6 parts bismuth oxide gives a good brass gloss. 6 parts gold, 1 part silver and 3 parts bismuth oxide gives a good yellow gloss. 3 parts gold, 1 part silver and 1 part bismuth oxide gives a greenish metal gloss. For brass or gold gloss, less than 4% gold is needed, by increasing the bismuth content. An addn. of boric acid, dissolved in benzyl alcohol and boiled until all the water is expelled, increases the tenacity and produces a stronger yellowish color. 3-10 parts of the soln. are added to the above mixt. Temperature affects the color. A mixt. of 3.5% gold, 1.18% silver and 2.7% bismuth oxide has a green gold gloss at 770°F and a reddish gold color at 834°F. At 896°F the coating is destroyed and discolored. P. D. H.

Correct decolorizing.—Dangers of over-decolorizing. L. SPRINGER. *Ceram. Indus.* **5** [5], 417-18 (1925).—Manganese peroxide is the oldest commercial decolorizer. In many cases, antimony oxide is added to produce a clarifying effect. Traces of cobalt oxide are sometimes added. An addition of saltpeter prevents a reduction of the manganese oxide. Nickel and selenium compds. are better decolorizers in open tanks. Nickel oxides in the least excess, give the glass a gray shade. Selenium is the most nearly perfect decolorizing agent, but is sensitive to atmospheric conditions. Rare earths may be used as decolorizers, but their actions have not been studied on a commercial scale. The above decolorizers act from a phys. standpoint; that is, they impart to the glass a distinct color which tends to complement the color given to the glass by impurities. Arsenic oxide may be used to reduce an excess of manganese oxide or selenium. Saltpeter also reacts chemically to change the blue-green shade of ferrous iron oxide into the less visible yellow shade of the ferric oxide. S. gives a number of commercial decolorizer mixts. and batches for different types of glass, with decolorizers for each. P. D. H.

Screw conveyor makes for a homogeneous batch. ANON. *Ceram. Indus.* **5** [5], 419 (1925).—The installation of a screw conveyor at the Glenshaw Pa. Glass Co. plant feeds the raw glass batch into the batch bin and prevents segregation of the coarse and fine mat. The screw conveyor also adds to the mixing of the raw batch and makes an easier melting glass. P. D. H.

The nature and constitution of glass. W. E. S. TURNER. *Jour. Soc. Glass Tech.* **35,** 147-166 (1925).—The properties and charac. of glass which have long been known are reviewed, and some of the latest discoveries are pointed out. T. states that any search for the nature and constitution of glass should be based upon the following fundamental factors: the molecular complexity of the glass, and in the case of glasses which are composed of two or more subs. the chem. compds. existing in the glass. Research previously done on the molecular complexity is reviewed with the conclusion that we may regard silicate glasses as containing silicate molecules. In reviewing the available knowledge on the existence of chem. compds. in glass it is stated that little help can be derived from the existing information, but it is evident that very useful work may be done in studying the compn. property diagrams of series of glasses prepd. so as to cover a wide range of compn. In final conclusion T. states that the fund. data available for making accurate deduction as to the constitution of glass is very meager and he points the direction that should be followed by anyone who endeavors to secure this data. R. M. K.

Glasses as supercooled liquids. G. TAMMANN. *Jour. Soc. Glass Tech.* **35,** 166-85 (1925).—Reference is made to the research that established the fact that glass is a supercooled liquid. The capacity of a liquid for supercooling is detd. by 2 factors; (1) the number of crystn. centers formed in unit volume in unit time and (2) the linear rate at which needle crystals grow into the supercooled liquid. Both of these values are dependent upon the temp. of the supercooled liquid. A glass is defined as a non-crystd. strongly undercooled fusion. When a liquid is rapidly cooled to a known temp. one of the following will happen; (1) crystn. begins at one or more points, from which needle crystals shoot out rapidly through the liquid; (2) spherulitic crystals are formed more slowly or (3) the liquid remains completely transparent even when strongly supercooled. For easily fusible substances the definite max. number of crystn. centers is attained as a rule with about 100°C of supercooling. The rate of crystn. gradually increases up to a definite temp. and then gradually decreases. In discussing the relation between the viscosity of liquids to their supercooling it is stated that the temp. of the m. p. has no influence on the mobility of the liquid, and the viscosity of the liquid in this region is a constant function of the temp. A procedure is described with which it is possible to estimate the temp. of both max. and the m. p. of the devitrification product in the glass. It has been found that the presence of foreign substances has a decided influence upon the "nucleus number" of crystn. centers. Four different cases showing the supercooling capacities of binary mixts. are discussed. R. M. K.

Color imparted to glass by fluorine compounds. KITSUZO FUWA. *Jour. Jap. Ceram. Assn.* **32** [379], 280-94 (1924).—The paper comprises the results of 412 meltings. I. Cryolite and constituents of glass. Nature of bivalent elements in glasses seems to play the most important rôle, their sensibility to the opalizer being in order of Pb, Zn, Ba, Mg and Ca. II. Sodium silico-fluoride and constituents of glass. Na_2SiF_6 acts similarly to cryolite. III. Fluorspar and constituents of glass. The action of CaF_2 is weaker than that of cryolite or sodium silico-fluoride. IV. Sodium fluoride and constituents of glass. The influence of bivalent elements is just as given in I. V. Comparison of the fluorine compds. and the cause of opalescence. (1) Comparison of the fluorine compds. The white coloration must be due to fluorine, because it is the sole element common to the four compds. The weak action of fluorspar suggests that lime hinders the action of fluorine or that a part of CaF_2 is dissolved in glass as such. AlF_3-theory of WEIUREIB (1885) is not valid, because glasses are opalized with about same amts. of cryolite, sodium silico-fluoride or sodium fluoride. (2) Fluorine compds. and constituents of glass. Indications are that the milky color is more easily produced in potash glasses than in soda glasses and also that an increase in alkalis of glasses favors the coloration. As for bivalent elements, glasses with the metals are more susceptible to the coloration than those with alkaline earth metals. F. supports the theories advanced by SCHALLER (1909) or SMULL (1915) which attribute the opalescence to colloidal silica produced by the action of fluorine compds. on silica; at the same time, fluorides of metals or alkaline earth metals should be present in glasses contg. these metals. VI. Fluorine compds. and KNO_3. Addition of KNO_3 to batches contg. fluorine compds. has little effect on the white coloration. VII. Fluorine compds. and As_2O_3. As_2O_3 has no influence upon the action of the fluorine compds. S. K.

Color imparted to glass by sulphur and its compounds. KITSUZO FUWA. *Jour. Jap. Ceram. Assn.* **32** [380], 314-27 (1924).—The paper covers the results of 388 meltings. I. Sulphur. Potash glasses are generally colored darker than soda glasses; *e.g.*, 0.5% S colored $K_2O.CaO.3SiO_2$, $1.3K_2O.CaO.6SiO_2$, $1.3K_2O.ZnO.6SiO_2$ and $1.3K_2O.PbO.6SiO_2$ reddish orange, orange, yellowish orange and light yellowish green resp. while similar soda glasses were yellow, light yellowish brown, light green and light greenish

blue resp. Batches with S foam remarkably, and the glasses are generally brittle. II. Sulphides. (1) Antimonic sulphide. Colors given by Sb_2S_5 are somewhat lighter than those given by S, although some are colored very fine; *e.g.*, $K_2O.CaO.3SiO_2$, $K_2O.ZnO.3SiO_2$ and $K_2O.CaO.0.5B_2O_3.3SiO_2$ were colored a beautiful yellow by 1% of the sulphide. $R_2O.PbO.3SiO_2$ + 1% Sb_2S_5 and $R_2O.PbO.0.5B_2O_3.3SiO_2$ + 0.5 − 1% Sb_2S, formed light greenish alabasters; lead was reduced in these glasses. (2) Cadmium sulphide. The influence of variation in the glass-constituents on color given by CdS is slight. Potash and borosilicate glasses tend to produce alabasters. $K_2O.CaO.0.5B_2O_3.3SiO_2$ + 5% CdS and $K_2O.MgO.0.5B_2O_3.3SiO_2$ + 3-5% CdS produced fine yellow. (3) Potassium sulphide. The coloring action of the sulphide is much weaker than that of sulphur. Generally speaking, the sulphides are entirely or partially decomposed at high temps. and set sulphur free which may react with bases or produce sulphates or thiosulphates. The free sulphur or its products of reaction with bases impart to the glasses colors varying from yellow to dark red and the coloring power of the sulphides is nearly propl. to their content in S. The sulphates may produce alabasters or opalescent glasses. The sulphides may color glasses as such. III. S and KNO_3. KNO_3 acts against S, the influence being stronger in soda-glasses than in potash-glasses. KNO_3 tends also to produce sulphates in potash glasses as evidenced by the formation of alabaster. IV. S and As_2O_3. As_2O_3 acts like KNO_3 except that it produces an alabaster very rarely. V. S and R pot. tartrate. Effect of the tartrate is generally slight. S. K.

Color imparted to glass by selenium. KITSUZO FUWA. *Jour. Jap. Ceram. Assn.* **32** [380], 327-42 (1924).—F. reports on the results of 482 meltings which can be summarized as follows: (1) The color given to glass by metallic Se is influenced by its constituents. In $aR_2O.bRO.cSiO_2$-glasses, it is lighter when R_2O is Na_2O than when R_2O is K_2O, and is brown in soda-glasses while it is pink or red in potash-glasses. Boric acid encourages the development of pink. *E.g.*, colors of the glasses $1.3R_2O.RO.6SiO_2$ with 0.1% Se are: Na-Ca light brown, K-Ca dark red, Na-Mg brownish pink, K-Mg light orange pink, Na-Zn slight greenish blue, K-Zn orange, Na-Ba orange, K-Ba light pinkish yellow, Na-Pb yellow and K-Pb colorless. (2) KNO_3 acts against Se, though its influence is slight. (3) The effect of potassium tartrate depends on the constituents of glass. When RO is a metal oxide, no effect is observable, while it darkens the color if RO is an alk. earth. (4) As_2O_3 acts against Se. Soda-glasses are more susceptible than potash-glasses. S. K.

Coloring glass with phosphates. KITSUZO FUWA. *Jour. Jap. Ceram. Assn.* **32** [382], 431-40 (1924).—I. Bone ash. Expts. with $R_2O.RO.3SiO_2$ or $R_2O.0.5B_2O_3.3SiO_2$: (1) Variation in the kind of alkalis has no effect on the coloration. (2) Pb-glasses are most favorable, being followed by Ba- and Zn-glasses. (3) Boric acid encourages the action of bone ash. RO has remarkable influence on the coloration of the borosilicate glasses; ZnO favors it most, then BaO and PbO follow, MgO-glasses being most insensitive. Expts. with $1.3–1.7R_2O.RO.6SiO_2$ or $R_2O.B_2O_3.6SiO_2$: (1) The borosilicates require the least amt. of bone ash for the coloration; then Pb- and Ba-glasses come, Ca-glasses being most inactive in this respect. (2) Kind of R_2O has no effect. (3) Variation in the propn. of CaO seems to have no effect. The other RO has not been exptd. II. Na_2HPO_4. The phosphate acts like bone ash. In glasses of $R_2O.RO.3SiO_2$-type, the influence of RO is as described in I. In those of $R_2O.RO.0.5B_2O_3.3SiO_2$-type, B_2O_3 acts against the phosphate. III. $Ca_3(PO_4)_2$. In glasses of $R_2O.RO.3SiO_2$-type, PbO favors the opalescence most, being followed by BaO; B_2O_3 encourages it. In $R_2O.RO.0.5B_2O_3.3SiO_2$, PbO and BaO aid the action of the phosphate, ZnO being less active in this respect. IV. Comparison of bone ash, Na_2HPO_4 and $Ca_3(PO_4)_2$, and the cause of opalescence. The coloring action of the Na_2HPO_4 is weaker than that of the other agents in $R_2O.RO.0.5B_2O_3.3SiO_2$ while no remarkable difference is observable in R_2O.

$RO.3SiO_2$. The opalescence seems to be caused by the suspension of P_2O_3. V. $Ca_3(PO_4)_2$ and KNO_3 or As_2O_3. KNO_3 and As_2O_3 seem to slightly favor the action of the phosphate. S. K.

Coloring glass with arsenious acid. KITSUZO FUWA. *Jour. Jap. Ceram. Assn.*, **32** [383], 469-70(1924).—Coloring action of arsenious acid on glasses of $1.3R_2O.RO.6SiO_2$. and $R_2O.B_2O_3.6SiO_2$-types was investigated. The amt. of arsenious acid varied from 5 to 25%. The effect of rehtg. the glasses was observed. Conclusions: (1) A large quantity of arsenious acid, say 15%, produces an opalescence on melting the batches or on rehtg. the glasses. Such quantity of the acid depends on their constituents. The color owes probably to the presence of As_2O_3. (2) Glasses contg. arsenious acid are reduced by flames and colored brown on their surface. The phenomenon is more remarkable in potash-glasses than in soda-glasses. S. K.

Color given to glass by carbon and its compounds. KITSUZO FUWA. *Jour. Jap. Ceram. Assn.*, **32** [383], 471-90(1924).—Coloring action of retort carbon, cane-sugar, tartaric acid and oxalic acid on glasses with formulas of $R_2O.RO.3SiO_2$, $R_2O.RO.0.5B_2O_3$. $3SiO_2$, $1.3–1.7R_2O.RO.6SiO_2$ and $R_2O.B_2O_3.6SiO_2$, also effect of KNO_3 and As_2O_3 on the action of retort carbon have been exptd. The results can be summarized as follows: (1) Carbon or org. compd. produces a color which varies from light yellow or brown to dark red. Carbon introduced in excess often floats on the surface of glass or is suspended in glass, imparting a light black to it. (2) Constituents of glasses have remarkable influences upon the colors given by carbon or its compds. It is dark in Ca-, Mg- or Ba-glasses while Zn- or Pb-glasses are colorless or colored lighter. Kind of alkalis have some influence, soda glasses being colored lighter than potash-glasses. (3) The content in alkalis has no material influence upon the colors provided that the constituents of the glasses remain unchanged. (4) The coloring power of org. compds. increases with their content in carbon and decreases with their content in oxygen and hydroxyl group. (5) The coloring action of carbon is not easily extinguished by KNO_3. In soda-glasses, the coloration is destroyed by KNO_3 about 10-20 times as much as carbon. KNO_3 can only weaken the coloration in potash-glasses. (6) The coloration is destroyed by arsenious acid about 3-5 times as much as carbon in some soda-glasses, while most potash-glasses keep the color though it may be weakened to some extent. Thus, arsenious acid acts more strongly against carbon than KNO_3 does. (7) The effect of KNO_3 on the mutual action of carbon and As_2O_3 is negligible. S. K.

Investigation on the ray-transmission of glass. I. On the transparency to ultraviolet rays of alkali-lime glasses and the manufacture of glasses which transmit ultraviolet rays. JUSEI SUGIE. The Osaka Indus. Lab. *Bull.* **5** [11], 26 pp. (1924).—Invest. on the transparency to ultraviolet rays of glasses is reported. It comprises 51 glasses in $0.7\text{-}1.6Na_2O.0.9\text{-}1.5CaO.6SiO_2$ (*a*) 9 glasses obtained by substituting whole or a part of soda in (*a*) with potash and 17 glasses made by adding MgO, Al_2O_3, B_2O_3, As_2O_3, MnO_2, P_2O_5, Sb_2O_3, WO_2, Fe_2O_3, ZnO, BaO, SnO, CdO, TiO_2 or ZrO_2 to (*a*). The results are shown with photographs. Conclusions are: (1) There are no regular relations between this property of the alkali-lime-glasses and their compns. Glass $1.0Na_2O.1.4CaO.6SiO_2$ was most transparent to the rays, the min. wave-length being 237$\mu\mu$ for a 1.50 mm-thick plate. Glass $1.0Na_2O.1.5CaO.6SiO_2$ was least transparent, the min. wave-length being 279$\mu\mu$ for the thickness of 1.50 mm. (2) The transparency increases as the thickness of a glass diminishes. However, the increase in glasses poorly transparent to the rays is smaller than that in glasses whose transparency is great. (3) The effect of replacing soda entirely or partially with potash on the transparency is negligible. (4) P_2O_5 does not injure the transparency of the alkali-lime glasses. The influence of TiO_2, Sb_2O_3 or Fe_2O_3 is remarkable. That of MgO or Al_2O_3 is also fairly great. S. K.

American Window Glass Machine Co., Annual Report. ANON. *The Glass Worker*, **45** [5], 17(1925). F. G. J.

Start campaign to stop use of heavy window glass as polished plate glass in building in New York. ANON. *The Glass Worker*, **45** [5], 30(1925).—Speculative builders who sell their buildings before they are completed are the principal offenders. An easy test is given. F. G. J.

Sheet glass production. W. E. S. TURNER. *Nature*, **116,** 482(1925).—Describes the modern production of sheet glass in a paper published in the *Jour. Roy. Soc. Arts* for July 24. O. P. R. O.

Utilization of glass in modern buildings. ANON. *Indus. Aus.* and *Min. Stand.*, **74,** 277(1925).—Luxfer fire-resisting glazing has been tested and approved all over the world by societies interested in fire prevention and fireproof construction, among whom must be mentioned the Brit. Fire Prevention Comm. of London, whose Red Books have shown the world what is required in fire-resisting bldgs. Luxfer fire-resisting glazing is composed of small segments of glass ¼″ in thickness, accurately ground to size, with thin strips of copper between the glass segments that are afterwards deposited with copper, making the whole plate into a homogeneous whole. It is this heavy electro-deposit, as well as the mat. used, together with accuracy of workmanship, that makes Luxfer preëminent as a fire-resisting mat. O. P. R. O.

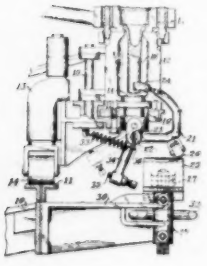
Boric oxide as a constituent of glass. H. GOULDING-BROWN, London, 1924. This brochure presents, in concise form, up-to-date information of interest to those engaged in the manuf. of glass, and especially of resistance glass. Every care has been observed to include only statistics of proved accuracy, and, although the booklet is written in language intelligible to the glassworker without a complete knowledge of chemistry the particulars should be of service to the glasswork's chemist also. O. P. R. O.

The manufacture of plate glass at the Chantereine works. I. L. *La nature* **53,** ii, 49-53(1925).—An illustrated description of the latest methods of plate-glass manuf. from the raw materials to the finished product. (*C. A.*)

The development of the art of glass melting. M. VON ROHR. *Naturwissenschaften* **13,** 619-22(1925); cf. *C. A.* **18,** 3690.—Historical. (*C. A.*)

The vapor pressure of some glass components at room temperature. FRITZ BORN. *Z. Elektrochem.* **31,** 312(1925).—From Nernst's and Trouton's equations it is estd. that the highest (O) pressure reached by metal oxides used in glassware at room temp. is from 10^{-16} to 10^{-22} mm. (*C. A.*)

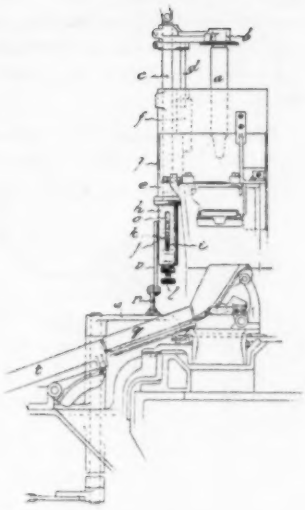
PATENTS

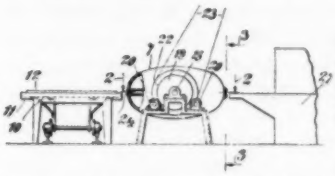


Blank-centering device for glass forming machines. RICHARD LA FRANCE. U. S. 1,557,850. Oct. 20, 1925. In a glass forming mach. the combination of means to suspend a blank of plastic glass, a centering device, means to move said device transversely of the blank into engagement with the lower end thereof while the blank is suspended, and a mold to enclose said blank.

Apparatus for feeding molten glass. HARRY BLACK CHALMERS. U. S. 1,558,790, Oct. 27, 1925. In app. for feeding molten glass wherein a container is provided with an outlet for molten glass which is controlled by a reciprocating needle

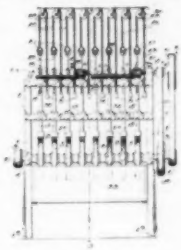
having a fixed connection with guide shafts supported reciprocating in bearings, a sleeve extension on one of the guide shafts, a resiliently mounted abutment supported by said extension, and means for placing the said abutment in the path of movement of the guide shaft upon each alternate movement of the needle to vary the sizes of charges delivered from the feeding app.

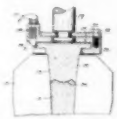




Process and machine for fire-polishing glass. JOSEPH HASTREITER, U. S. 1,559,094, Oct. 27, 1925. In a glass-working app. the combination with a polishing table and a leer, of a drum intermediate the table and leer, said drum having two interior flat walls, closely spaced and enterable from one side, and means to rotate said drum to cause reversal thereof.

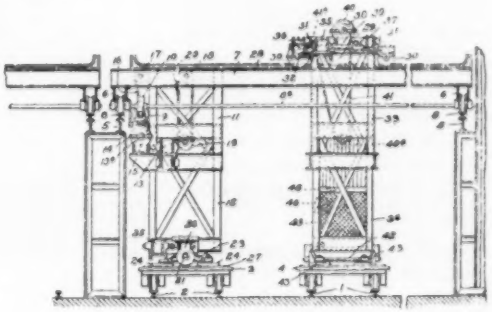
Machine for polishing or grinding glass knobs and similar articles. JAMES CHESTER POWELL. U. S. 1,559,643, Nov. 3, 1925. In a polishing mach. a frame, a series of rotatable abrasive members carried by the frame, two series of vertical slidable and spaced shafts, carried by the frame, means to slide the shafts, work holders carried by the shafts, a gear on each shaft, gears mounted on the frame in the spaces between the shafts of each series and meshed with the gears of the shafts, a second gear on one shaft of each series of shafts, a horizontal shaft, a pair of gears on the horizontal shaft meshed with the respective second gears of the said two shafts, and means to drive the horizontal shaft.





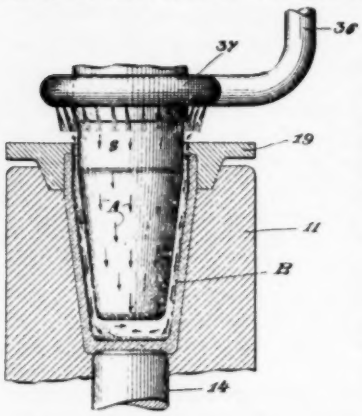
Glass-molding apparatus. ALBERT N. CRAMER. U. S. 1,559,854, Nov. 3, 1925. In a glass forming mach., the combination of a mold open at one end to receive its charge, a closure for the mold, a head carrying said closure, a detent by which said closure is locked to the head, and means to withdraw said detent, said closure being thereby released and free for instantaneous removal from the head.

Process and apparatus for surfacings heat glass. JOHN H. FOX. U. S. 1,559,862, Nov. 3, 1925. In combination in app. for transferring glass sheets from one carrier or car to another carrier or car lying to the side thereof and turning it over, which comprises a vacuum frame mounted for vertical movement above the first carrier, a pivotal support for the frame whereby it

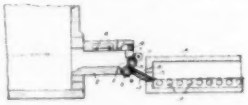


may be inverted to bring the glass sheet carried thereby up, a second vacuum frame mounted for lateral movement from a position over the first carrier, and vacuum frame to a position over the other carrier, and means whereby the second frame may be moved up and down.

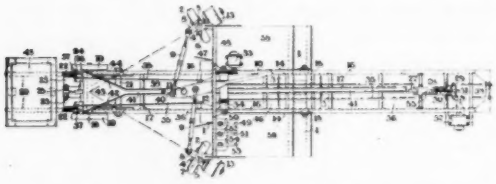
Method and apparatus for cooling glassware and the like. PETER KUCERA. U. S. 1,560,062, Nov. 3, 1925. The method of cooling pressed glassware and the like which comprises forming an article by pressing a suitable charge between movable shaping members, withdrawing certain of the shaping members from the finished article and maintaining a cooling medium under press. between the articles and the withdrawn member during the entire time the member is leaving the article and with the space between the article and the withdrawn member open to atmosphere. Glass shaping mechanism comprising a pair of coöperating mold members, means to bring said mold members together to mold a glass article, means to sep. said mold members after the article has been formed, and means to circulate a cooling fluid into and out of the article while the mold members are being sepd.

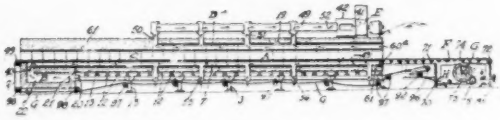


Apparatus for making sheet glass. FREDERICK GELSTHARP. U. S. 1,560,080, Nov. 3, 1925. Means for continuously forming a glass sheet or ribbon from a body of molten glass, comprising a pair of parallel cooled rolls contacting with said molten body, a table with a flat upper surface in advance of the rolls adapted to receive the glass from the rolls, means for cooling the table by a circulating fluid to promote the formation of a supporting skin upon the lower surface of the glass, and transfer means in advance of the table for receiving the glass and carrying it forward.



Charging apparatus for use with annealing ovens. PAUL ALPHONSE HUBERT MOSSAY. U. S. 1,560,393, Nov. 3, 1925. A railless app. for charging annealing ovens and for like purposes, comprising a carriage provided with ground wheels, a charging arm supported by said carriage and adapted to reciprocate relatively thereto, a charge carrier connected to one end of said loading arm, said charge carrier being adapted to rest on the ground, and means for automatically maintaining the ground wheels of said carriage with their axes radial to the center of oscillation of said charge carrier when the charging arm is extended relatively to said carriage, substantially as and for the purpose hereinbefore set forth.

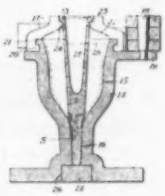




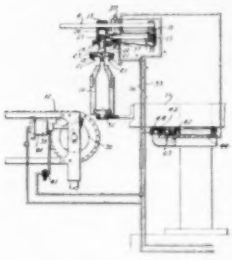
Apparatus for annealing glassware. VERGIL MULHOLLAND. U. S. 1,560,481, Nov. 3, 1925. A leer for annealing glassware, comprising a

tunnel, a htg. flue and a cooling flue associated with said tunnel, means for causing htg. and cooling media to flow through said flues at subatmospheric press. and means located at intervals along said flues for controlling the temps. therein.

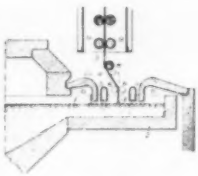
Manufacture of glassware. DE WITT C. HAMILTON. U. S. 1,560,784, Nov. 10, 1925. The method of making a stemmed article of glassware, comprising placing a charge of molten glass in the cavity of a blank forming mold, inserting a plunger into said cavity to form the bowl portion of the blank having an integral stem depending therefrom, withdrawing the plunger, removing the blank from the forming mold and placing it in a one-piece blowing mold, and blowing the bowl portion of the blank into the desired form, substantially as described.



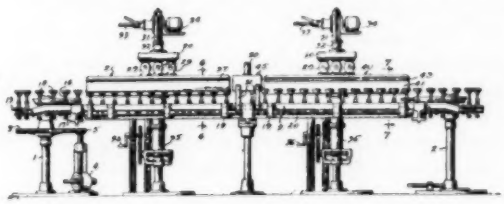
Take-out device for bottle-blowing machines. JAMES W. LYNCH. U. S. 1,561,451, Nov. 10, 1925. In a glass working mach., a movable table and series of molds carried thereby, means for opening said molds at a predetd. point in their movement, a conveyor adjacent said point, and a take-out device for transferring glassware from said molds at said point to said conveyor, said take-out device comprising a laterally movable carrier, a vertically movable yoke mounted thereon, and arms carrying grippers at their outer ends pivotally connected to said carrier intermediate their ends and to said yoke at their ends remote from the grippers, said pivotal connections having limited freedom of movement whereby raising said yoke first swings and then elevates said grippers, and continuously acting means for restraining said grippers against lifting movement until the gripping action is completed.



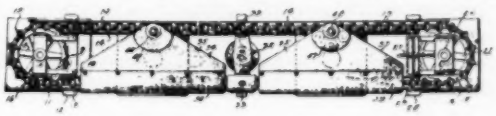
Drawing and flattening sheet glass. WILLIAM L. MONRO. U. S. 1,561,478, Nov. 17, 1925. The method of drawing and flattening a single sheet of glass, which comprises drawing the sheet vertically from a bath of molten glass, and then deflecting the sheet from the vertical through an angle materially less than a right angle by passing it against a flattening roller, substantially as described.



Method of and apparatus for glazing and polishing glassware. ALBERT BREAKENRIDGE KNIGHT. U. S. 1,562,341, Nov. 17, 1925. The herein described method of polishing and glazing glassware which consists in subjecting the ware to the action of a polishing burner, lowering the temp. of the ware, and subjecting it to the action of a glazing burner.



Glass-working burner. ALBERT BREAKENRIDGE KNIGHT. U. S. 1,562,342, Nov. 17, 1925. A device of the character described comprising a substantially fan shaped casing divided to form a plurality of substantially fan shaped mixing chambers having a common wall at their outer ends, said wall being provided with a



plurality of sets of burner nozzles each set communicating with one of said chambers, means for conveying articles of glassware progressively past said nozzles, means for supplying fuel to said chambers, and means for independently controlling the flow of fuel to said chambers whereby heat areas of progressively increasing intensity are provided adjacent said nozzles in the path of travel of the glassware.

Heavy Clay Products

Up-to-date brick plants. A. SCHMIDT. *Ziegelwelt*, **56**, 390-92(1925). H. G. S.

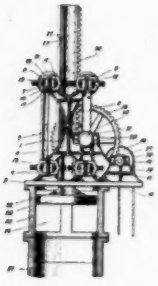
The Berra hollow tile construction. ANON. *Ziegelwelt*, **56**, 469-71(1925). H.G.S.

The brickmakers of Kish. E. MACKAY. *Brit. Clayworker*, **34**, 150-52(1925).—Brickmaking as practiced by the ancient Arab tribes is described. H. G. S.

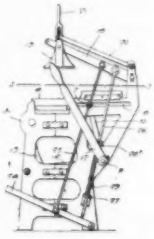
A call for extended brick-making operation, XIV. Methods of manuf. ANON. *Brit. Clayworker*, **34**, 153-54(1925). H. G. S.

Face brick by Chicago methods. T. B. HUESTIS. *Brick and Clay Rec.*, **67** [8], 554-55(1925).—The new plant which is being built for the Building Brick Co. of Ill. at Sundown, Ind. is described. The brick will be made by the production methods now used in the manuf. of common brick. A large capacity steam shovel will dig the clay, which is to be hauled to the plant in 10-yard dump cars. The clay will be fed by gravity into the crushers and thence through an automatic feeder into the new type Hadfield-Penfield grinders. The ground clay is to be elevated onto elec. vibrating screens and conveyed directly to the pug mill. The auger mach. will have a capacity of 500,000 brick per day. The brick will be hacked automatically. Drying will be done with waste gases from the boilers. Mechanical setters will be used for setting the brick in the kilns. The kiln sheds will be provided with an overhead crane for loading and unloading. The brick will be fired by the new Lambert process. This process uses, for fuel, oil atomized with steam. The bottom courses are brought quickly to the desired temp., the fire is turned out and steam press. forces the ht. up through the top courses. P. D. H.

PATENTS



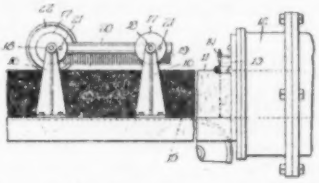
Clay-pipe-forming press. SAMUEL I. FLOURNOY. U. S. 1,557,821, Oct. 20, 1925. A clay pipe forming press comprising a pipe-forming cylinder having means whereby clay may be introduced into the cylinder, a plunger for forcing the clay through the cylinder, a rack bar on the plunger, having grooves in its respective edges, sets of rollers at opposite edges of the rack bar, the rollers of each set having flanges engaging the edge grooves, and means for actuating the rack bar.



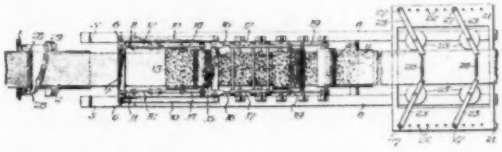
Brick machine. ELIE BLANCHETTE. U. S. 1,558,781, Oct. 27, 1925. In a brick mach. of the class described, a table, a fixed wall at one edge of the table provided with a plurality of vertically disposed slots, a pivoted wall at the opposite edge of the table and provided with a plurality of slots, a plurality of partitions slidable across the table through the slots of the walls, means for simultaneously sliding the partitions across the table through the slots of the wall and swinging the pivoted wall to an upright position, said means comprising a shaft, arms extending from the shaft, a rod extending through the ends of the partitions, a structure in which the shaft is journaled and provided with slots for receiving the rods, arms extending from the shaft and having slotted

terminals receiving the rods, other arms projecting from the shaft at an angle to the first arm, curved members extending from the pivoted wall and engageable with the second arm so that when the partitions are moved across the table, said second arms will engage the members for swinging the pivoted wall to a vertical position, and spring means engaged with the members for normally urging the pivoted wall to a lowered position.

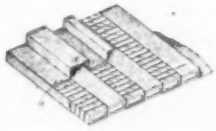
Machine for producing brick faces. IVAN N. DOUGHTY. U. S. 1,559,682, Nov. 3, 1925. App. for forming plastic surfaces which comprises a plurality of elements having substantially hemispherical ends and means for bringing said ends into and out of engagement with the surface.



Means for and method of making ornamental brick. PORTER C. FARRIS. U. S. 1,559,948, Nov. 3, 1925. In a brick mach. device, the combination of a die adapted continuously to form a clay slab with a smooth surface means for removing the clay forming the smooth surface and means for depressing portions of the newly formed surface of the slab.



Method of packing enamel brick. JOHN FRANCIS BOORAEM. U. S. 1,561,210, Nov. 10, 1925. The method of packing brick in cars for transport which consists in arranging the brick in superimposed horizontal courses within the car with a plurality of transverse rows of brick in each course, and interposing between said transverse rows of brick as the courses are successively arranged in position, a continuous sheet of cushioning mat. approx. of the same length and width as the interior of the car and having portions extending alternately above and beneath the transverse rows of brick and between the opposed ends of the brick in adjacent rows to bond said transverse rows of brick together and prevent relative shifting movement of the individual brick or contact of the horizontally or vertically adjacent brick with each other.



Refractories

Testing of load-bearing capacities of refractories at high temperatures, and a suggested method for standardization. A. J. DALE. *Gas. Jour. Suppl.*, **171,** 46-49(1925); *Jour. Soc. Chem. Ind.*, **44B,** 717(1925).—Methods which involve the rapid application of load are unsuitable as standard methods because the supporting structure at high temps. is comparable with a viscous fluid. Methods depending on penetration of loaded rods into the mat. are also questionable because the results are typical only of the surface and not of the brick as a whole. Any test is wrong if it involves merely one detn. of the deformation in a specified time under a specified load at a specified temp. A satisfactory standard test should involve the continuous recording of the progress of subsidence under a static load at a uniform rate of rise of temp. One test should be made at a relatively high load, (50 lbs. per sq. in.), to det. tendency to viscous deformation at comparatively low temps. and plastic deformation at high temps. A second test under a low load, (10 lbs. per sq. in.), should be used to see if plastic deformation is absent up to the max. temp. H. H. S.

A refractories discussion in a meeting of the Ceramic Society. WALTER EMERY. *Pottery Gaz.* **50** [580], 1567-71(1925).—Refracs. used in the construction of (*a*) intermittent ovens and kilns, (*b*) continuous ovens and kilns, (*c*) frit kilns and (*d*) supports for ware set in ovens and kilns, are discussed by E. as to their phys. and chem. requirements. P. D. H.

Contribution to the study of refractories. V. BODIN, *Céramique*, **28**, 98-99(1925). H. G. S.

Firing grog in continuous kilns. ANON. *Brit. Clayworker*, **34**, 152(1925).—In firing grog in continuous kilns it is advisable to mold the clay first into brick and dry them thoroughly. The brick should be set so as not to choke off the draft. Where a clay contains ironstone and other impurities it is best to calcine these in lump form so that those lumps which show the impurities may be thrown away. Otherwise the impurities will become hopelessly mixed through the clay. H. G. S.

A study on ignition-plug. MASAJIRO WATAYA. The Osaka Indus. Lab., *Bull.* **5** [8],30 pp. (1924).—I. Ignition-plug of the ROBERT BOSCH. anal. of a plug made by the German Co.: Ign. loss 0.11, SiO_2 66.43, Fe_2O_3 2.01, Al_2O_3 3.72, CaO trace, MgO 27.78, K_2O 0.02, Na_2O 0.02 and TiO_2 trace. It had a slip contg. rutile and a colorless glaze on it. II. Exptl. 27 bodies were compounded on the base of the above anal. Manchurian talc, Tagawa quartzite, Korean kaolin, Honyama Kibushi and Shugan-stone were used. Anal. of Shugan-stone: Ign. loss 5.16, SiO_2 44.60, Al_2O_3 0.57, Fe_2O_3 0.91, CaO 0.25 and MgO 47.82. Thick tubes were pressed semi-dry, dried and biscuited at 900°–1000°C. They were coated with slips, prepd. from same bodies to which 1.5% of rutile had been added, and were glost-fired to 1350°–1520°C. A glaze $\left\{\begin{matrix}0.33Na_2O\\0.33CaO\\0.33PbO\end{matrix}\right\}0.13Al_2O_3\left\{\begin{matrix}1.73SiO_2\\\\0.53B_2O_3\end{matrix}\right\}$, maturing at 1100°C, was applied on the tubes. Tests for sudden cooling, sudden htg., elec. resist. at high temps., puncture voltage and micro-structure were done. III. Conclusions. (1) The BOSCH's ignition plug is probably a talc-porcelain. (2) Limestone is not a suitable flux for the body. (3) Clay acts as a strong flux in magnesian bodies. (4) Shugan-stone porcelains have strong elec. resist. at high temps. although they do not resist sudden changes in temp. (5) Several bodies better than that of the R. BOSCH were obtained. (6) Bodies made of 80 pts. calcined talc and 10–15 pts. clay subs. are best for the talc plug. (7) Kaolin is better than a plastic clay with respect to the resist. to sudden changes in temp. S. K.

Carbonized clay. ANON. *Indus. Australian and Min. Stand.* **74**, 443(1925).—It is a well-known fact that clay attains its max. porosity in the 1st stage of calcination. At this stage it is charged with volatilized hydrocarbons. As the calcination is continued contraction of the clay begins. So long as the carbonized clay remains in a deoxidizing atmosphere it will resist the destructive action of ht. beyond the highest temps. reached industrially, and it will also resist acids. By mech. mixing, a complete union of clay and carbon as in carbonized clay may be obtained. The best way to carry out the process is to grind the crude clay to the required fineness. The clay and coal are then placed in a fur. so that during heating the volatile matter of the coal is absorbed by the clay to complete satn. Dissociation of the gases takes place in the substance of the clay itself, the residuary carbon being retained. Calcination is afterwards continued until the clay has attained its limit of contraction, the temp. depending on the nature of the clay treated. The surplus gas can be utilized in other ways. The product is a powder which can be briquetted in the usual way. If the granular subs. is fairly fine, and is sufficiently compressed, the briquet obtained may be used as made. If the grains are coarse, a 2nd thermal treatment may be necessary to complete the process. Briquettes thus

made, do not contract to any appreciable extent when exposed to fire. They are said to have been in use for 4 months in a fur. at a temp. of 1750°C and over, the fur. being allowed to cool during the night, without showing any deformation. They did not swell or spall, and were not affected by the slag or scale. It may also be used as a filtering mat. The vapors of hydrochloric and sulphuric acid have no effect on goods made of it. The hardness of carbonized clay is just below that of carborundum. It is amorphous, and all kinds of articles for grinding can be made from it. Comparative heat-condy. tests have given the following results: Ordinary refrac. brick, 1, carbonized brick, 2, graphite, 4 to 5, carborundum, 4 to 6. Practical tests show that the resist. of the brick to slagging, due to iron scale and slag, is very great, no penetration of slag having been found. The process, it is said, also liberates the iron oxides which many clays contain, these as well as ochers and alkalis being obtained as by-products. In a powdered state carbonized clay may be used for fur. linings, repairs, protecting the outside walls of gas retorts, etc. Its non-contractibility makes it specially suitable for the repair of open-hearth fur. in operation. A process based upon the carbonization of clay by a special method, for the production of a highly refrac. mat., has been patented by WALTER SMITH of London. O. P. R. O.

Refractory materials used in the iron and steel industry. CYRIL S. FOX. *Trans. Min. and Geol. Inst. of India*, **20**, 176(1925).—Of the more important refrac. mat. used in the various branches of the iron and steel industry, bauxite, chromite, dolomite, fire clay, graphite, magnesite, quartz, and other forms of siliceous mat., and zircon, all except chromite, occur in India in commercial quantities. Sillimanite has recently been discovered in Assam. This is an ideal refrac. for general purposes, meeting the tests as stated in the *Mining Journal* of 1923. It has a definite m. p. above 1830°C and does not soften below this temp.: its coeff. of cubical expansion is exceedingly small; it is a chem. compd. of great stability, and, being neutral in compn., is practically immune to the attacks of acid or basic subs. at all temps. below its m. p. The massive mat. sillimanite is one of the strongest and toughest minerals known. O. P. R. O.

Utilizing waste fire brick. JAMES JOHNSTON. *Power* **62** [17], 655(1925).—J. believes that the use of waste fire brick for refrac. mat. is expensive; refracs. should be purchased from reliable refrac. mfrs. C. J. H.

Furnace ash as a refractory material. HUGH E. WEIGHTMAN. *Power*, **62** [15], 557(1925).—Observations of fur. temp. have been made showing that 3000°F is the max. in power plant of the U.S. Certain ash will withstand this temp. when properly selected and bonded. Curves and photographs are given illustrating the use of bricks made from ash. C. J. H.

How Standards Bureau helps the refractories industry. ANON. *The Glass Worker*, **45** [6], 19(1925).—Extracts from the Ann. Rept. of the Director covering (1) Comparing the properties of commercial refracs. of the plastic fire-clay type with fire-clay bricks, (2) Comparing tests with other testing labs. of the properties of fire clay as a mortar, (3) An invest. of tank block to det. the factors affecting resist. to corrosive action of glass in service. Four tanks have been tested in a year. No conclusions as yet. F. G. J.

Laboratory production of pure magnesia ware. R. F. MEHL, J. L. WHITTEN, and D. P. SMITH. *Indus. and Eng. Chem.*, **17** [11], 1171(1925).—The magnesia is fired to the highest temp. to be used, cooled, mixed with shellac and an organic solvent, molded, and fired again. F. G. J.

BOOKS

Construction and operation of modern converter steel and small Bessemer works. HUBERT HERMANNS. Publ. W. Knapp, Halle (Saale), 1925. 250 pp. Metallurgical

processes of Bessemer's and Thomas's method; metallurgical and mech. appliances; converters and blowers; accessory plants, especially for prepg. and mfg. refrac., slag grinding plants, equipment and management of Bessemer works. One chapter devoted to mfg. of dolomite bricks. Location and equipment of the plant. Raw mat., anal., production methods. W. S.

Chamotte and Silica. L. LITINSKY. Leipzig. Published by Otto Spamer, Leipzig, 1925. 286 pp. Three parts: properties, applications and test. (1) Chem. compn. mech. strength., loading under heat and other mech. properties. (2) Iron and steel works, gas indus., ceram. and chem. industries, elec. fur., gas generators and boiler plants. (3) Description of methods to test properties as given in (1). Treatment of refrac., some other refrac. besides quartz and chamotte, refrac. mortar, cement and glazes. W. S.

PATENTS

Manufacture of articles from highly refractory materials and articles formed. STEPHEN A. MYLER. U. S. 1,559,275,Oct. 27, 1925. The method of mfg. a refrac. article, comprising mixing graphite and pulverized soft coal together with petroleum oil until it becomes putty-like, shaping the mixture in a mold and subjecting it to heat until the oil is dried therefrom, dipping the shaped article in tar, and then completely carbonizing the article.

Plastic fire brick. WILLIAM A. L. SCHAEFER. U. S. 1,561,571, Nov. 17, 1925. A plastic firebrick comprising a clay rich in alumina apportioned into raw and calcined parts in the proportion of nine and two mixed together and with ground burner fire brick in the proportion of eleven and eighteen.

Refractory composition. WILLIAM A. FARISH. U. S. 1,561,641, Nov. 17, 1925. A non-recrystallized refrac. compn., consisting of a refrac. elec. fur. product a carbonizing binder and borax.

Manufacture of chamotte bricks. SVEN EMIL SIEURIN. U. S. 1,561 492, Nov. 17, 1925. In a process for the manuf. of chamotte brick, adding to the main mass of the brick, a binding mass consisting of an intimate mixt. of finely divided silica and fire clay, the said mixt. being such that a sample of it after htg. to glowing heat contains 73–90% silica, and then firing the masses.

Graphite, process for purifying. Brit. Pat. 232,936. *Quarry and Surveyors' and Contractors' Jour.*, **30,** 305 (1925).—Process for purifying, enriching, or refining crude graphite. Crushing, then to trituration in a damp state in a special refining tube or app., then to sepn. in the wet state by sifting or passing through a sieve, and finally to flotation for the purpose of sepg. out the particles of refined graphite, those which are coarsest being again passed to the refining app. and again washed and sieved and floated in order to increase their richness or purity. The graphite is mixed with a detd. propn. by wt. of carbonate of soda raised to 700°C in a gas-heated continuous kiln, and the operation may then be carried out in either of the 2 following methods: (*a*) The product obtained from the kiln may be passed again to the refining tube or app. and then be sieved in the set state and treated by flotation. (*b*) If hydrochloric acid is obtainable at a commercial rate the mat. may be treated with dilute acid and sol. products are obtained, together with silica in an extremely finely divided state. By washing, the sol. products and any excess of acid are removed, and the resulting mat. is sieved or sifted by means of the pneumatically operated vibrator to separate out the silica.

O. P. R. O.

Terra Cotta

Brick architecture and colored finishes. K. DÜMMLER. *Ziegelwelt*, **56,** 388-90 (1925).

H. G. S.

Brick architecture in North Germany. ANON. *Ziegelwelt*, **56**, 421-22 (1925). H. G. S.

A good vitreous terra cotta slip at cones 4-5. ANON. *Ceram. Indus.*, **5** [5], 429 (1925).—The results of "A Study of Slips for Standard Finished Terra Cotta, Cones 4-5" by H. E. Davis and J. S. Lathrop show: (1) a low clay content causes crazing, (2) a high clay content decreases vitrification, (3) the use of Cornwall stone, up to 50% is beneficial, (4) the feldspar content may be from 0 to 35%, (5) flint increases the maturing temp. and has a tendency to produce crazing, (6) whiting, in very small amts., decreases the firing range and up to 5% acts as a refrac., and (7) the addn. of soda ash, an electrolytic agent, has no apparent fluxing action. P. D. H.

White Wares

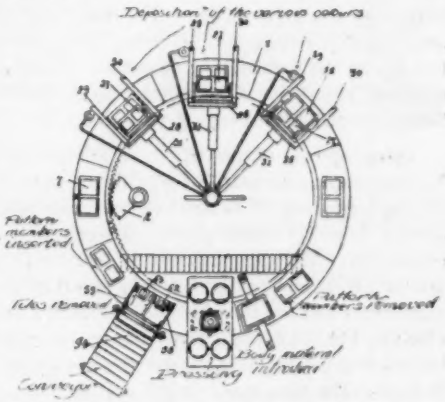
Glazes. C. TROSTMANN. (Translated by W. L. SHEARER and A. W. HOLZMANN.) *The Ceramist*, **6** [6], 689-707 (1925).—A translation of Chap. V, Pt. I, of Die Keramik im Dienste von Industrie und Volkswirtschaft by FELIX SINGER which is an elementary practical discussion of the nature, prepn. and classification of raw and fritted glazes and the methods employed for eliminating glaze defects. Typical SEGER formulas together with the equivalent compns. on a percentage by wt. basis are given for lead glazes and enamels, earthy glazes (including slip and Bristol glazes) and salt glazes. Mats. and methods used in prepg. colored glazes are described. A critical discussion of SEGER's rules for the correction of crazing and shivering defects concludes the article. A. E. R. W.

Test on porosity of technical porcelain. RUDOLF PFEIFFER. *Elektrotech. Zeit.* **46**, 1078-80 (1925).—Tests made according to the rules of the V.D.E. are not sufficient to det. absolute dense porcelain from hygroscopic ones. Description of several methods of testing and a new method. W. S.

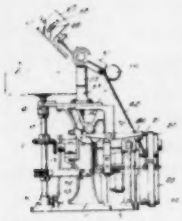
Cracks in paving tile. ANON. *Brit. Clayworker*, **34**, 901 (1925). H. G. S.

PATENTS

Apparatus for the manufacture of ceramic tiles. ARTHUR HENROZ. U. S. 1,557,935, Oct. 20, 1925. In app. for mfg. ceramic tiles, the combination of a hopper; a movable strainer therebeneath; and a device connected to the strainer to impart a succession of sudden shocks or vibrations thereto, said device comprising a differential piston having working surfaces of unequal areas, and a distributor for automatically supplying a fluid under pressure to act constantly upon the surface of smaller area and intermittently upon the surface of greater area.

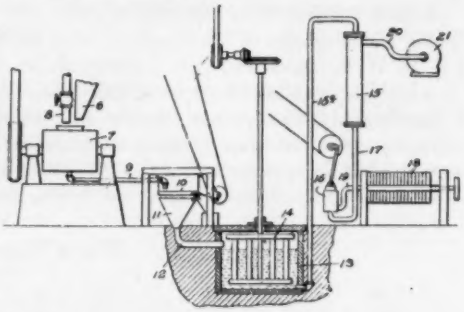


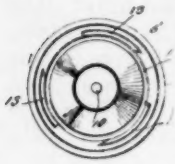
Bat-forming machine. ALBERT C. WARD. U. S. 1,559,513, Oct. 27, 1925. In a bat forming mach. of the character described, a turn table, a spreader blade, means for rotating the turn table, means for moving the spreader blade slowly inwardly toward and slowly downwardly toward the central point of the turn table during the rotation of the same, means for automatically quickly raising the spreader blade from the mat.,



and additional means for moving the spreader blade longitudinally to one side of the turn table.

Method of producing clay bodies and apparatus used. GROVER W. LAPP. U. S. 1,561,002, Nov. 10, 1925. That step in the art of preparing clay for use in producing ceram. ware, which consists in subjecting a moving mass of clay in plastic state to a mixing action in which portions of the mass are moved across the longitudinal axis thereof.





Pottery mold. MIKE L. PASCARELLO. U. S. 1,562,361, Nov. 17, 1925. A pottery mold including a male and a female member, and a clay cutter between and carried by one of said members, comprising an annular member whose outer edge is beveled inwardly and provided with equi-distantly spaced notches, and one of the end walls of each notch being cut angularly to provide a cutting edge.

Equipment and Apparatus

A simple gas heater for drying ovens. W. M. MILLER. *Fuels and Fur.*, **3** [10], 1159-63 (1925).—This heater consists essentially of a motor driven fan which delivers air to the combustion chamber of special design which itself consists of an outer steel shell with an inner shell about half the diam. of the outer shell, the inner shell being fastened to the top of the outer shell and extends about $\frac{2}{3}$ of the distance toward the bottom of the outer casing. The inner shell is lined with refrac. through which there are several portholes for delivering air to the gas which is fed in by a burner entering the top of the combustion chamber. These combustion chambers can be used either singly or in multiple. Oven temps. up to 1000°F can be obtained with this type of heater. Several sectional drawings of various heaters of this type are given. R. M. K.

Spiral springs of quartz. K. SLIUPAS AND C. V. BOYS. *Nature*, **115**, 943 (1925).—In connection with work on gravitation in the Univ. of Lithuania, Kaunas, S. had need of a spiral spring of unusual delicacy and succeeded in his first attempt to make one from a thread of fused quartz. Three centigrams gave an extension of no less than a centimeter. Method employed is described; oxyacetylene flame was used to melt the quartz. B. tried to make a quartz spiral in the eighties of last century but failed. He describes a method by which he produced a spiral of glass thread. H. GREVILLE-SMITH (*Nature*, **116**, 14 (1925)) gives account of making quartz springs. The Silica Syndicate has made a considerable number of such springs, having 15 to 30 coils from 0.5 to 1.5 cm. in diam. The fiber was 1 or 0.2 mm. in diam. Springs of these dimensions will support a total load of 0.8 gram and stretch 9 mm. upon the addition of 0.1 gram. They are more sensitive than the first spring of S. He states that this was greatly exceeded in delicacy by some of his later springs. H. D. H. DRAME (*Nature*, **116**, 315 (1925)) gives details of a method of making springs from quartz fibers of about .001 cm. diam. The fiber, originally straight, is wound about a quartz tube to which both of its ends are attached.

Thus constrained it is heated for a short time at a temp. above annealing point of fused quartz. For this diam. one min. at 1100°C suffices. The coiled spiral then permanently assumes that form and keeps it after removal from the tube. By this process very sensitive springs can be prepd. One such spring was extended by its own wt. at the rate of 30 km. per gram. O. P. R. O.

The pug-mill and its blades. ANON. *Brit. Clayworker*, **34**, 154-55 (1925).—An invest. of the different blades of horizontal pug mills often proves to be of considerable advantage in saving power. H. G. S.

Some quaint brickmaking patents. W. EMERY. *Brit. Clayworker*, **34**, 192-94 (1925). H. G. S.

Automatic machinery. ANON. *Céramique*, **28**, 93-97 (1925). H. G. S.

Handling and machinery. ANON. *Ziegelwelt*, **56**, 394-95 (1925). H. G. S.

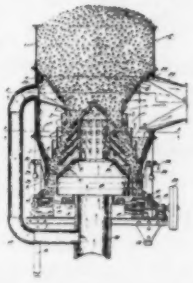
The manufacture of pyrometers. ANON. *The Ceramist*, **6**, 723-28 (1925).—A short illustrated description of the Engelhard plant. A. E. R. W.

Filter cones of porous ceramic material. R. SCHWARZ. *Z. angew. Chem.* **38**, 748 (1925).—Disks for use in glass funnels. They filter rapidly, do not clog, are unaffected by acids and alkalis or sudden temp. changes. Made by W. HALDENWANGER, Spandau. (*C. A.*)

Quartz apparatus with filter bottom. G. F. HÜTTIG AND HANS KÜKENTHAL. *Chem. Ztg.*, **49**, 716 (1925).—A crucible of about 15 cc. capacity with perforated bottom, made by Schott and Gen. Cf. *C. A.* **18**, 917, 2849; **19**, 1829. (*C. A.*)

PATENTS

Drying apparatus. DANIEL V. SHERBAN. U. S. 1,558,119, Oct. 20, 1925. A drying app. including a receiving hopper, spaced ring plates beneath said hopper, a series of conical plates spaced from the ring plates, means for rotating the conical plates and means for passing hot gases between the conical plates and ring plates.

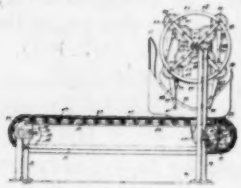


Preventing the sticking of plastic materials to molds. HARRY M. WEBER. U. S. 1,558,440, Oct. 20, 1925. In molding plastic resinous substances having a tendency to stick to the mold the step which consists in dusting the mold prior to molding with a dusting powder comprising a metallic soap.

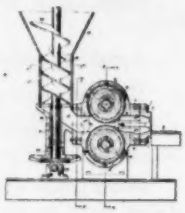
Screening and separating machine. JOSEPH T. SIMPSON. U.S. 1,561,031, Nov. 10, 1925. In a mach. of the class described, a fan and means for driving it, a fan chamber having its lower portion consisting of a conical screen, a conical casing surrounding the fan chamber, and removed a short distance therefrom, discharge spouts for the chamber and the casing at the apexes thereof, and an exhaust pipe connected to the upper part of the annular space between chamber and casing.

Apparatus for purifying talc and the like. GEORGE F. HANNAM. U. S. 1,560,910, Nov. 10, 1925. In an app. for the treatment of pulverized talc bearing mat., a horizontal housing provided with a plurality of substantially vertical chambers whose walls are formed of screen mat., means comprising a blower and a suction fan for establishing a circulation of air from one end of the housing to the other through the screens, said housing having an initial compartment provided with an adjustable gate or valve and in which the impurities fall and from which the pure particles of talc are carried in the moving stream of air.

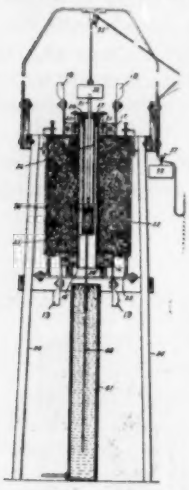
Clay-product-cutting machine. MAX MUELLER. U. S. 1,560,601, Nov. 10, 1925. A clay products cutting mach. comprising an endless conveying table, a cutting drum provided with a plurality of meshing gears in operative relation with said table, and a means for simultaneously operating said drum in proper unison with the movement of said table.



Clay press. PAUL F. LOICHOT. U. S. 1,561,612, Nov. 17, 1925. A clay press including a housing having a die in one side, a pair of rolls within the housing for forcing clay through the die in a column and an auger in the housing at an angle to the axis of the rolls for feeding clay to the rolls.



Silica glass. LEVI B. MILLER. U. S. 1,562,115, Nov. 17, 1925. An elec. fur. adapted for shaping plastic silica which comprises a container providing a vertical htg. zone having a discharge port located at its lower end, an elec. heater therefor, a refrac. crucible supported in said htg. zone and having a die aligned with said discharge port to permit of the extrusion of mat. therethrough and means for extruding a charge from said refrac. container.



Kilns, Furnaces, Fuels and Combustion

Improving the operation of oil burning furnaces. ANON. *Fuels and Fur.*, **3** [10], 1113–14 (1925).—This article is a summary of a paper given by M. H. MAWHINNEY at the annual convention of The American Society for Steel Heat Treating in September. The paper was entitled "Oil Burning Equipment for Industrial Furnaces." The chief causes for hot spots in fur. are discussed under the following headings: (1) size of combustion flues, (2) size of combustion space, (3) excessive radiation through walls, (4) size and number of openings other than flues, (5) arrangement of baffles. R. M. K.

Cleaning gas producer lines. E. P. ARTHUR. *The Glass Worker*, **45** [3], 15 (1925).—Gas mains should be of ample size. A good rule is "never let the velocity of the gas stream exceed ten feet per second." Valves often give trouble and should have poke holes and be blown out regularly with stream. Steam jets may be permanently installed. Steam will not hurt the gas. The tar removed can be reburned. Soot can be burned under hand-fired boilers or used to color glass. It is said to give a very fine amber. F. G. J.

Contribution to the study of continuous kilns. M. E. DAMOUR. *Céramique*, **28,** 116–25 (1925). H. G. S.

Automatic feeders for kilns. V. BODIN AND P. GAILLARD. *Céramique*, **28,** 139-50 (1925). H. G. S.

The heat insulation of kilns and other high temperature installations. A. T. GREEN. *Brit. Clayworker*, **34,** 204-7 (1925). H. G. S.

My procedure and observations during firing especially with the use of Bohemian brown coal. J. WOLF. *Sprechsaal*, **58,** 739–45 (1925).—W. reports the results of his firing tests with lab. direct fire and muffle kilns. H. G. S.

Water-smoking in circular continuous kilns. K. DÜMMLER. *Ziegelwelt*, **56**, 293–95 (1925). H. G. S.

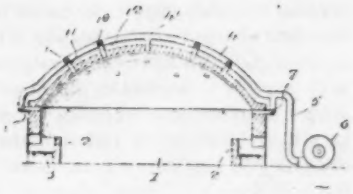
Kilns of the brick industry. ANON. *Ziegelwelt*, **56**, 421-22 (1925). H. G. S.

Advantages and disadvantages of the tunnel kiln. RUDOLPH WITTE. *The Clay Worker*, **84** [4], 296-97 (1925).—W. discusses the advantages of the tunnel kiln in lowering the fuel consumption in the firing of brick. The drying of brick by the WITTE system, which uses waste heat from the tunnel kiln and from boilers, is described. P. D. H.

Firing of bricks in the round kiln according to new methods of firing. Criticism of the Seydel theories. M. HAGEN. *Tonind. Zeit.*, **49**, 603–04 (1925). Seydel theories. See also *Tonind. Zeit.*, **48**, 955 (1924); **49**, 11 (1925). W. S.

PATENT

Heating systems for kilns. JAMES B. AGNEW AND ABIRAM A. OEFFNER. U. S. 1,562,135, Nov. 17, 1925. The combination with a down draft kiln, of a means for introducing air under press. at varying angles through the top and sides of the kiln above the fire boxes thereof, for the purpose set forth.



Geology

General rules about clay deposits. G. PASCHE. *Ziegelwelt*, **56**, 466-67 (1925). H. G. S.

Cobalt ores. EDWARD HALSE. *Imp. Inst. Mon.* (London), (1924).—Cobalt ores and their occurrence, characters and uses. O. P. R. O.

A treatise on Missouri clays. M. H. THORNBERRY. School of Mines and Metallurgy, Univ. of Mo., *Bulletin*, **8**, 9-69 (1925).—The clays of Mo. are described in detail with analyses and phys. tests. (*C. A.*)

Bauxite and aluminium in 1924. J. M. HILL. U. S. Geol. Survey, *Mineral Resources of U. S.* 1924, Part I, 21-9 (preprint No. 4, published Aug. 4, 1925). (*C. A.*)

Chemistry and Physics

Action of electrolytes on clays. III. SEIJI KONDO. *Jour. Soc. Chem. Ind.*, Japan, No. 323, 1-10 (1925).—Chap. III. Theoretical consideration. 1. Acidic nature of high grade clays. This can be summarized as follows: (1) Elec. condy. of malachite green solns. is not materially affected by the action of the clays. (2) Adsorption curves of some electrolytes are close to those of ordinary chem. reactions. (3) Equil. of the adsorption of malachite green or $BaCl_2$ is not materially affected by the variation in the propn. of water provided that those of clay and salt remain constant. (4) Clays adsorb considerable amts. of cations of some electrolytes, leaving no trace in the solns. (5) When pure clays are treated with an excess of malachite green, the products are usually dark green. The color-base is almost colorless while its salts are green. (6) Fired (very pure) kaolins are rehydrated in most air. They adsorb considerable amts. of cation of malachite green. Their adsorption curves show marked changes in adsorption at those temps. where thermal changes were assured to take place. 2. Coagulation and peptization of clay suspensions. ROHLAND's theory, which attributes action of alkalis to mutual re-

pulsion of colloidal particles charged with negative electricity and OH′, and action of acids to mutual attraction of colloidal particles charged with negative electricity and H˙, fails to explain the following facts: (1) No OH′ is detectable in the suspensions of pure clays, unless alkalis are added in much excess; (2) No H˙ is detectable in the suspensions of pure clays unless acids are added in much excess; (3) An excess of alkalis causes the coagulation; (4) Salts which do not sustain hydrolysis cause the coagulation. The author's theory.—A. Alkalis. If an alkali, *e.g.* KOH, is added to an ideally pure clay in water, it will diffuse into the interior of the mass and react with the latter: $HA+KOH \rightleftarrows KA+H_2O$—(1); Where A represents a kaolinitic acid radical or its fraction regardless of its real compn. The kaolinite soon dissociates: $KA \rightleftarrows K^{\cdot}+A'$—(2); A part of the kaolinite ion is strongly adsorbed by clay particles and imparts to them a negative charge. When the concn. of the potassium is sufficiently great, and the particles correspondingly charged, the attraction between particles is lessened and the potassium diffuses into the surrounding liquid taking in its wake the charged particles. Thus the peptization takes place. An excess of the alkali affects the reaction (2); Clay particles lose their charge and the clay slip is coagulated. When natural clays are concerned, the action of alkalis is more complicated, as they contain several kaolinites. If they are mixed with water, the kaolinites will dissolve in water and dissociate: $MA \rightleftarrows M^{\cdot}+A'$—(3); Where $M^{\cdot}$ represents an equiv. of cation. The slip will be more or less peptized. If an alkali, *e.g.* KOH, is added to the suspension, more kaolinite will be produced and the degree of peptization is increased. The alkali will also react with MA: $MA+KOH \rightleftarrows KA+MOH$—(4); These reactions will be affected mutually. An excess of alkali must disturb the equils. (2) and (3), and the slip is coagulated. Such amts. of alkalis for Korean kaolin are given. B. Acids. If an acid, *e.g.* HCl, is added to a clay suspension, its $H^{\cdot}$ combines with kaolinite ion: $M^{\cdot}+A'+H+Cl'=HA+M^{\cdot}+Cl'$—(5); Since kaolinitic acid is almost insol. in water, the particles lose their charge and the mutual repulsion ceases. Thus the suspension is coagulated. C. Salts. If a salt is added to a clay suspension, its cation acts to displace those of kaolinites, *e.g.*: $KA+AgNO_3 \rightleftarrows AgA+KNO_3$—(6). Here the solubility of kaolinite plays the most important rôle. An addition of a salt reduces the ionization of the kaolinites in the suspension, causing coagulation at its certain amt. The coagulating power of various salts are compared. It varies with the soly. of the resulting kaolinite and the strength of acids which their anions form with H. 3. Plasticity. Plasticity is probably caused by the mutual attraction of clay particles, the attraction being opposed by the elec. repulsion which is the direct consequence of the ionization of kaolinites and kaolinitic acid. Colloidal kaolinitic acid plays an important rôle here, as it has enormous surface. Such colloidal kaolinitic acid has probably been produced by the hydrolysis of kaolinites and also by the action of acids on them. S. K.

Chemistry of colloidal clay. Anon. *Céramique*, **28**, 69-74 (1925); *Chem. Age*, 209-14 (1923). H. G. S.

Density, porosity and gas inclusions in clay, kaolin and light silica. M. A. Bigot. *Céramique*, **28**, 75 (1925). H. G. S.

The adsorption power of clays. M. P. Brémond. *Céramique*, **28**, 153 (1925). H. G. S.

The relation between the chemical composition of clays and their fusibility. L. Bertrand. *Céramique*, **28**, 155-64 (1925).—B. represents the reln. between the chem. compn. of clays and their fusibility by means of charts. H. G. S.

Clays as soil colloids. A. F. Joseph. *Soil Sci.*, **20**, 89-94 (1925); *Jour. Soc. Chem. Ind.*, **44B**, 730 (1925).—The inorganic colloid content of most soils is apparently identical

with the clay content as detd. by mech. analysis. Clays of diverse origins show a correlation between chem. compn. and phys. properties, the data being the silica-alumina ratio on the one side, and the "inhibitional" water-holding capacity, and rate of evapn. measured by KEEN'S method, on the other. H. H. S.

Heat of wetting of soils, and the force of adsorption. G. J. BONYOUCÓS. *Soil Sci.*, **20,** 67-72 (1925); *Jour. Soc. Chem. Ind.*, **44B,** 730 (1925).—Heat of wetting increases with the temp. at which soils have been dried, the max. being reached by soils dried at 107°. The amt. of H_2O effective in producing the heat is small, 1.4–12.1%, and of this only a very small part is responsible for the greater part of the heat evolved. Assuming the heat of wetting to be due to adsorption and compression of the water film, the force of adsorption may be calcd.; it amounts to a very high value. H. H. S.

Hygroscopicity of gels of ferric oxide, alumina and silica. B. AARNIO. *Geol. Komm. Finland Geotekn. Meddel.*, **25,** 1-25 (1920); *Jour. Soc. Chem. Ind.*, **44B,** 756 (1925). $Fe_2(OH)_6$ pptd. by NH_4OH retains 10% H_2O at 100°, 1.5% at 200°, and 1% at 300°, and the corresponding hygroscopicities are 34%, 42% and 29.6% respectively. At 700° no water is retained, and the oxide is no longer hygroscopic. The hygroscopicity of $Al_2(OH)_6$ similarly pptd. is 24% after heating at 100°, 45% at 400°, 44% at 800°, 17% at 1000°, and 0.54% at 1200°, at which temp. the oxide still retains 0.2% water. Silica gel has 41% hygroscopicity at 100°, 56% at 200°, 45% at 400°, 50% at 500°, 0.62% at 1000°, 0 5% at 1100°. H. H. S.

Employing X-rays for investigation of cements. R. NACKEN. *Zement*, **14,** 419-22, 437-39 (1925).—Research work done by W. DYCKERHOFF which results in detg. the unstable modification of the compn. $Ca.SiO_2$ with a surplus of CaO as hydraulic supporter of the Portland Cement. W. S.

Relation between dye adsorption of clays and their behavior in rubber compounds. H. R. THIES. *Indus. and Eng. Chem.*, **17** [11], 1165 (1925).—Clays of the same chem. type do not behave similarly when compounded in rubber, one type gives good cures and high tensile strengths, the other slow cures and inferior tensile strengths. These 2 types of clays adsorb different amts. of dye from soln., the clay which is good for rubber usage adsorbing the smaller amt. of dye. F. G. J.

Critical study on zinc analysis. L. A. CONGDON, A. B. GUSS, AND F. A. WINTER. *Chem. News*, **131,** 65-68, 113-17 (1925); *Jour. Soc. Chem. Ind.*, **44B,** 740 (1925).—Nineteen different methods of zinc estn. are studied. The method recommended is to ppt. as sulphide from a soln. contg. potassium acetate by H_2S under press., to dissolve ppt. in HCl, evap. with H_2SO_4 and weigh as sulphate. To separate Zn from Mg and alkalis, ppt. pyridic zinc thiocyanate, and ignite to oxide. H. H. S.

Aluminum from clay. W. BARTH. *Metall. u. Erz.*, March 1, 1925. *Queensland Govt. Min. Jour.*, **26,** 257 (1925).—Dry clay is made moist with sulphuric acid and heated to 60°C for several hrs. The sulphates first formed are decomposed into sulphur dioxide and oxides, and the alumina dissolved out by dilute soln. of caustic soda. Hydrochloric acid instead of sulphuric gives better results. The exptl. plant using this process yields about 3 T of alumina per day. 2nd method: mix the clay with ammonium sulphate, heat the mixt. to a temp. which volatilizes the ammonia but does not decompose it into nitrogen and hydrogen. The alumina, as well as some iron, can be dissolved out as sulphates, and from the soln. the iron first, and next the alumina, are pptd. by a method not disclosed. The ammonia is recovered for further use. A more economic method than either of these is the fusion of clay or a highly impure bauxite, mixed with coke or coal, in an elec. fur. Under these conditions the iron and silica in the mixt. form ferro-silicon, and the aluminum compds. are converted into alumina. O.P.R.O.

Crystal structure of titanium and chromium. R. A. PATTERSON. *Phys. Rev.*, **26,** 56-9 (1925).—Precision measurements of the crystal structure give for Cr (99.8% pure) a body-centered cubic structure with $a_0 = 2.872$ A. U. and for Ti (99.9% pure) an hexagonal close-packed structure with $a_0 = 2.951$ A. U., axial ratio $c = 1.590$. Computed densities for Cr and Ti, resp., are 7.23 and 4.49. (*C. A.*)

The two-stage transformation of magnetite into hematite. LARS A. WELO AND OSKAR BAUDISCH. *Phil. Mag.*, **50,** 399-408 (1925).—On heating the magnetic oxide, Fe_3O_4, in a stream of O_2 it oxidizes to Fe_2O_3 at about 220° with sufficient rapidity for the change to red to be observed. The low-temp. oxidation is accompanied by no change in crystal structure and the magnetic property is not only retained but the max. permeability increases from 2.93 to 3.39. If this Fe_2O_3 is then heated in a neutral atm. (N_2) to 550° the max. permeability falls to 1.045 and the cryst. structure changes to that of ordinary Fe_2O_3, showing that magnetic properties depend on the cryst. form and the change is a function of temp., not of the state of oxidation. If Fe_3O_4 be heated in the absence of O_2, it can be raised to 800° without permanent loss of permeability. (*C. A.*)

Permutoid structure. H. KAUTSKY AND G. HERZBERG. *Z. anorg. allgem. Chem.*, **147,** 81-90 (1925).—Such compds. as "*siloxen*," $Si_6O_3H_6$, behave as if the mol. structure was very loose, and are called *permutoids*. It is essential for this type of structure that the bodies which constitute it are neither sol. nor possess appreciable vapor pressure. In $Si_6O_3H_6$, H atoms are easily replaced with Cl, OH, NH_2, etc. Photomicrographic study shows the structure to consist of extremely thin laminations, probably only 1–2 mol. thick, packed closely together like sheets of paper. These packs are grouped in layers, the individual packs themselves being quite thin, sometimes only 1μ thick. In the case of siloxen, which is formed by the action of HCl on *calcium silicide*, such structure must have been produced by the action of the acid on the silicide crystals in only one direction. The great reactivity of these compds. is undoubtedly due to the enormous surface presented to reagents, and the resultant high degree of *adsorption* which this surface permits. In the production of permutoid structure if the chem. action of the reagent continues sufficiently long, the laminations become finer and finer, until finally a colloidal soln. is obtained. *Graphitic acid* and *biotite silicic acid* are examples of permutoids. Photomicrographs are shown. (*C. A.*)

The thermal expansion of fused salts. RICHARD LORENZ AND W. HERZ. *Z. anorg. allgem. Chem.*, **147,** 135-41 (1925).—Brunner expressed the relation between d. and temp. with the formula: $d = d_1 - b(t - 900)$, while Lorenz used $d = d_0 - at$, the coeffs. a and b being identical. JAEGER used the quadratic form $d = d_1 - a(t_1 - t_2) + b(t_1 - t_2)^2$, in order to give expression to deviations from the linear, although these are small. In order to obtain the coeff. of expansion of fused salts, the best results are obtained by bringing the interpolation formulas given in the literature into the form $d = d_t - at$. If the coeff. of expansion α is defined with the equation $v = v_t(1 + \alpha t)$, there is obtained by substitution $d_t = d_t - at + \alpha d_t - \alpha a t^2$. Neglecting the quadratic member because of the smallness of a and α, one obtains $\alpha = a/d_t$. A table is given in which α is calc. for various salts, and the values so obtained are used to test VAN DER WAALS' assumption that $\alpha T_k = \text{const.}$, in which T_k is the critical temp. In one column of the table the product αT_c is given, in which T_c is the temp. of the fused salt in degrees abs., and this product is approx. const. From the work of various investigators it should be 0.230, which is near the av. value obtained. This product is influenced by the direction coeff. γ, which becomes greater with rising crit. temp., making αT_c greater. Values are given for many salts. (*C. A.*)

The specific heat of air. K. NESSELMANN. *Z. tech. Physik*, **6,** 151-53 (1925).—The sp. heat of air in the region from −79.3 to 250° and up to 200 atms. pressure is satis-

factorily represented as a function of vT^{n+1} and $(v-b)/v=\beta$ by the equation: $C_p=C_p^o+[(4.76\beta-2.84)/(vT^{1.6}-4.34)]$, where C_p^o is the const. pressure sp. heat at zero pressure and b is VAN DER WAALS' const. (*C. A.*)

Knowledge of specific heats. SIEGBERT WIESNER. *Ann. Physik*, **76**, 439-43 (1925). **Correction.** *Ibid.*, **76**, 802.—Theoretical, dealing with the change from solid to liquid. (*C. A.*)

Titration of boric acid. M. CIKRITOVA AND K. SANDRA. *Chem. Listy*, **19**, 179-82 (1925).—Boric acid may be titrated by NaOH with phenolphthalein as indicator in concd. solns. of $CaCl_2$ and of LiCl as satisfactorily as in the presence of glycerol and certain sugars. It is supposed that the activity of the acid is increased by the dehydrating action of the added substance. (*C. A.*)

Behavior of cobaltous hydroxide. L. A. TEST AND D. L. SCOLES. *Proc. Indiana Acad. Sci.*, **34**, 163-64 (1924).—Pptn. of Co salts with excess of NaOH gives a blue ppt., supposedly consisting of a basic Co compd., which quickly changes to pink $Co(OH)_2$. The change is retarded by Ni to a degree depending on the quantity of Ni present and this has been suggested as a *qual. test. for Ni*. Sol. silicates also retard the color change and unless the NaOH soln. is freshly prepd. or reasonably pure the test cannot be depended on for detection of Ni in presence of Co. (*C. A.*)

Determination of sulphur in pyrites. GAETANO CASTELLI. *Rass. min. met. chim.* **63**, 20-1 (1925).—Complete directions are given for the detn. of S in pyrites by the method of LUNGE and that of GYZANDER in the forms recently approved by the technical committee of the Norwegian Govt. (*C. A.*)

PATENTS

Aluminum chloride process. HENRY I. LEA AND CLIFFORD W. HUMPHREY. U. S. 1,558,897, Oct. 27, 1925. A process that includes decomposing aluminum sulphate to separate its aluminum oxide content from its sulphur-oxygen content, using the sulphur-oxygen content for the production of a chlorinating agent, and chlorinating the oxide with that agent.

Process of making alkali-metal carbonate. GEORGE NELSON LIBBY. U. S. 1,558,901, Oct. 27, 1925. The process of making sodium carbonate which comprises adding finely divided magnesium oxide to a saturated soln. of trona.

Method for elimination of iron from solutions of leucitic rocks. UMBERTO POMILIO AND FRANCESCO GIORDANI. U. S. 1,559,179, Oct. 27, 1925. In a process of treatment of leucitic rocks, the steps of attacking them with acid, removing the silica from the soln. so formed, and pptg. the iron from said soln. by electrolysis, substantially as set forth.

General

Improvement in draft for the drying rooms. ANON. *Céramique*, **28**, 97 (1925). H. G. S.

Visit to the official syndicate laboratories. ANON. *Céramique*, **28**, 137-38 (1925). H. G. S.

Drying ceramic products. M. A. BIGOT. *Céramique*, **28**, 165-80 (1925). H. G. S.

Clayworkers visit Belgium. ANON. *Brit. Clayworker*, **34**, 157-64 (1925). H. G. S.

Shrinkage stress. ANON. *Brit. Clayworker*, **34**, 186-87 (1925). H. G. S.

Resistance to sudden temp. changes. ANON. *Brit. Clayworker*, **34**, 190-91 (1925). H. G. S.

The power of shrinkage. VA. *Ziegelwelt* **56,** 500 (1925).—In order to test the press. caused by the shrinkage of a plastic clay a nail was driven into a bar of plastic clay and this was allowed to dry. After the clay had dried the nail was removed by applying varying loads to pull the nail out. It was found necessary to use 40 kgs. to extract the nail from the dried clay. H. G. S.

Bureau of Standards investigation of feldspar. R. F. GELLER. *The Ceramist* **6,** [6] 708-16 (1925).—G. reports the progress of the invest. of the factors affecting glaze hardness. Glazes to be tested are abraded by a falling stream of sand and the amt. of surface worn away by a def. wt. of sand is detd. by an Ingersoll Glarimeter. Preliminary data is given in the form of a graph. Tne feldspar invest. is divided into 2 parts. The 1st part consists of a comparison of tests for softening point, fusion point, chem. anal., fineness as carried out by coöperating indus. labs. and the Bur. The 2nd part includes studies of viscosity of feldspars at softening temps., and the effect of feldspars on the firing range, porosity, color and strength of vitreous and semi-vitreous bodies. Petrographic examns. are given in all cases. G. reports outcome of studies on fineness, chem. anal., and quartz content to date. A. E. R. W.

The handwriting on the wall. ARTHUR D. LITTLE. *The Ceramist,* **6** [6] 717-22 (1925).—L. quotes examples to show the need of more fund. research in indus.
A. E. R. W.

Technical literature. ANON. *Jour. Soc. Chem. Ind.,* **44,** 950-75 (1925).—At the Second Conference of the Assn. of Special Libraries and Information Bureaus, held at Balliol College, Oxford, Sept. 25, the following subjects were discussed: World list of scientific periodicals, the International Institute of Bibliography at Brussels, the special library movement in America, coördination of technical intelligence, the translation of highly technical literature, efficient filing, and the press in relation to special libraries. H. H. S.

The Russian Journal of Chemical Industry has started publication in the English language with the hope that this will be the beginning of a closer intercourse between Russian and English-speaking chemists. (ANON. *Jour. Soc. Chem. Ind.,* **66,** 954 (1925)).
H. H. S.

Metallic cement. ANON. *Oil and Colour Trades Jour.,* **68,** 1246 (1925).—This cement is useful for attaching glass, metal and china to wood, and in cases where soldering is not available. Make 20 to 30 pts. of finely divided copper into a paste with oil of vitriol (sulphuric acid) and add 70 pts. of mercury, rubbing the whole well together. When the amalgamation is complete remove all the acid by washing the pan with boiling water, and allow the compound to cool. In 10 or 12 hrs. it becomes sufficiently hard to receive a brilliant polish and to scratch the surface of tin or gold. By heat it assumes the consistency of wax, and as it does not contract by cooling it has been recommended for dentists' use in filling teeth. To obtain the copper in a purely divided state, dissolve some blue vitriol (sulphate of copper) in water and then put in the mixt. a strip of clean iron; the copper will become deposited on the iron and should be scraped off and washed for use; or heat the cement 212°F and powder it in an iron mortar heated to 302°F. It then assumes the waxy consistency, and is harder in propn. as it contains more copper. O. P. R. O.

Outline of the Ceramic Experimental Station of the South Manchurian R. R. Co. ANON. *Jour. Jap. Ceram. Assn.,* **32** [380], 345-51 (1924).—History, equipments, subjects of research, fire-brick works, porcelain factory, hollow glass works and window glass works are described. S. K.

Gas temperatures throughout boilers burning pulverized coal. J. GOULD COUTANT. *Power*, **62** [15], 579 (1925).—The relation of stack temp. and superheat with respect to CO_2 content is discussed. When burning the same amount of fuel and air in a boiler fur., the exit temp. of the gases remains the same in each case and is not affected by the proportion of heat sur. directly exposed to the fire; superheat is not affected if the superheater is placed after 50% of the boiler sur.; an additional amt. of the direct boiler-heating sur. does not increase the total heat absorption. C. J. H.

Steel molding sands. ANON. *Nature*, **116**, 556 (1925).—The steel castings industry of Great Britain is notoriously inferior to the best continental practice, particularly German and Belgian. One reason for this is that insufficient attention is paid to molding sands and their properties. A comprehensive paper on "Steel Molding Sands and Their Behavior under High Temps.," presented at the recent meeting of the Iron and Steel Institute by A. L. CURTIS, shows how to remedy this defect. O. P. R. O.

The renumbering of Seger cones. KNUTH, MICHR, AND STEPHAN. *Tonind. Ztg.*, **49**, 1234-36 (1925).—The authors claim that the present method of numbering Seger cones is too complex because it requires a table to convert the cone numbers into temps. They suggest that the cones be numbered so as to correspond to the temp. at which they soften as below:

Cone No.	Temp. °C	New Cone No.	Cone No.	Temp., °C	New Cone No.	Cone No.	Temp., °C	New Cone No.
022	600	60	1a	1100	110	28	1630	163
021	650	65	2a	1120	112	29	1650	165
020	670	67	3a	1140	114	30	1670	167
019	690	68	4a	1160	116	31	1690	168
018	710	71	5a	1180	118	32	1710	169
017	730	73	6a	1200	120	33	1730	173
016	750	75	7	1230	123	34	1750	175
015a	790	79	8	1250	125	35	1770	177
014a	815	81	9	1280	128	36	1790	179
013a	835	83	10	1300	130	37	1825	182
012a	855	85	11	1320	132	38	1850	185
011a	880	88	12	1350	135	39	1880	188
010a	900	90	13	1380	138	40	1920	192
09a	920	92	14	1410	141	41	1960	196
08a	940	94	15	1435	143	42	2000	200
07a	960	96	16	1460	146			
06a	980	98	17	1480	148			
05a	1000	100	18	1500	150			
04a	1020	102	19	1520	152			
03a	1040	104	20	1530	153			
02a	1060	106	26	1580	158			
01a	1080	108	27	1610	161			

R. RIEKE in answer to this article opposes this change claiming that it has been the standard for the past 40 years and would necessitate changing all references of the past to the new numbers when referring to them. It would also cause considerable confusion among the practical men who have learned to use the cones according to their old numbers. H. G. S.

Ceramists' hints to Hoover. ANON. *Pottery Glass and Brass Salesman*, **32** [14], 13(1925).—Resolutions adopted by the Board of Trustees of the AMERICAN CERAMIC SOCIETY, being an expression of the views of its members based on their understanding of the present allocation of the ceram. work of the Federal Bureaus. F. G. J.

Pittsburgh Sheet successful in patent suit. ANON. *The Glass Worker*, **45** [5], 15 (1925).—Four of the five points in the patent suit of the American Window Glass Co. against the Pittsburgh Sheet Glass Co. were decided in favor of the defendant. Full text of the decision is given. F. G. J.

PATENTS

Coating compound, mold, and method of preparing molds and surfaces involved in molding operations. ROBERT L. SIBLEY. U. S. 1,559,289, Oct. 27, 1925. The method of prepg. vulcanizing molds, which comprises spraying the molding surfaces with a dilute aqueous soln. of sodium sulphonate.

Method of treating ceramic mixtures. HARRY SPURRIER. U. S. 1,559,652, Nov. 3, 1925. The process of treating ceramic mixtures consisting of evacuating the gases from the mass, and suddenly breaking the vacuum.

Cement. WILLIAM W. MARLETT. U. S. 1,561,095, Nov. 10, 1925. A cement composed of resin, coal tar pitch, linseed oil, vulcanized rubber, and a sufficient quantity of gasoline to bring the mixt. to the consistency of heavy molasses.

BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

Mary G. Sheerer, H. Clinton Baldwin, M. E. Manson, H. G. Wolfram	Art, Enamel	A. Silverman, A. N. Finn, C. E. Bales, L. C. Hewitt, F. H. Riddle, F. H. Rhead	Glass, Refractories, White Ware	E. C. Hull, G. M. Tucker, J. D. Martin, A. P. Potts	Terra Cotta, Heavy Clay Products

OFFICERS OF THE SOCIETY

E. Ward Tillotson, President
Mellon Institute, Pittsburgh, Pa.
F. H. Rhead, Vice-President
American Encaustic Tiling Co., Zanesville, Ohio
H. B. Henderson, Treasurer
Standard Pyrometric Cone Co.
1538 N. High St., Columbus, Ohio
Ross C. Purdy, General Secretary
Helen Rowland Fox, Assistant Secretary
Emily C. Van Schoick, Assistant Editor
Lord Hall, O. S. U., Columbus, Ohio

TRUSTEES

R. D. Landrum
A. F. Greaves-Walker
R. R. Danielson
J. C. Hostetter
C. Forrest Tefft
J. S. McDowell
R. L. Clare
C. C. Treischel
Paul E. Cox

Vol. 5 January, 1926 No. 1

EDITORIALS

AMERICAN CERAMICS FOR AMERICANS

A boycot on foreign-made ceramic ware would be provincialism most dwarfing and a short sightedness most defeating to America's possible attainments in clay, glass and vitreous enamels. Such provincialism and narrowness in perception is not in evidence in the editorial by Mrs. French on "Uses of Ceramics in Interior Decorating," nor by Dr. Langenbeck in his "Ideal Endeavor in Science and Art," nor by Professor Cox in his "American Ceramics for Interior Decorating," which editorials were in the September, 1925 issue of this *Bulletin*. Equally free from narrowness are the comments which appear in this issue of the *Bulletin*[1] and which were made in response to the questions raised by Mrs. French. We value the stimulating influence of those foreign ceramic wares which are distinctively artistic and of good quality. We want the world's best ceramics of all ages and climes in our homes, hotels, clubs and museums. We realize that the more general the purchasing demand is for the world's best in clay, glass and vitreous enamels, the larger will be the sales possibilities for the best that American ceramists can produce.

[1] See "American Ceramic Art Symposium," *This Bull.*, pp. 27-42.

"Business is business" in this our consideration of competition with foreign ware. We believe in tariff protection to equalize the cost of placing equivalent ware on the market shelves and display tables. We believe American ceramic wares are equal in appeal to the unprejudiced but they need to have the same cost chance on the market.

The complaint made by the purchasing agent against American ceramic wares does not appear to be justified. It would seem to be an alibi fabricated for self-justification if it were not that all purchasing agents and salesmen of decorative ceramics have the same prejudice for foreign wares. Facts known regarding the equal artistic merit and equal quality value of American wares certainly warrant us in taking exceptions to the opinions of these sales people but these facts will have to be made broadly known before they can contravene the prejudice which is quite general among ceramic sales people and which is shared quite largely by their customers. This situation warrants an educational campaign in news print and on the radio. The blame and the correction rests with ceramic manufacturers. The facts regarding ceramic wares made in America must be made very generally known and believed.

There are economic conditions which affect this situation. High wages cause high costs and high prices. American made ceramic wares have this as a very formidable handicap and it is folly to complacently rely on tariff protection to overcome these handicaps. Several manufacturers have demonstrated that American wares with the maximum of artistic merit and constitutional quality can with profit be produced and marketed in spite of the higher wages paid. These firms have the coöperation of plant operatives, the sales middlemen and buying public in making ware at the lowest cost and in convincing purchasers that it is second to none of its kind.

The use of foreign made china in so many of our hotels has been taken as evidence of their assumed or proven superiority. Some have thought the hotels use foreign made china by choice of their foreign born *maître d'hotel*. The facts are that the use of American hotel china is becoming more general because it has proven its value in service but the present producers of hotel china have not the shop capacity to meet the demands should every American hotel at once start to use American china exclusively. American chinaware is equaling and some there are who believe it is leading in quality and artistic merit, hence with adequate tariff to equalize costs it rests with china producers in this country to keep abreast the urge for changes in design, up with the best in quality, and equal with the importers in their sales efforts.

Three lessons stand out most prominently in these discussions: (1) our producers must cultivate their market, (2) operators must be trained and plant facilities obtained to produce higher quality ware

at lower costs, and (3) a combined art and science school training must be provided to develop ceramists with ability to vision and to carry visions through to sale of wares of distinctive merit.

No small part of carrying visions through to ware which will sell in competition with the world's best is the devising of economical means of production. Ceramists who can economically conceive and execute must have the fundamental science and engineering now given in our collegiate ceramic schools plus the fundamentals in form, design and coloring now given in our ceramic art schools. It seems to us that this symposium on American decorative ceramics has given emphasis to the need of a combination instruction course in applied ceramic art and science in which product and product requirement will be the prime point of view.

Americans, traveled and widely read, cannot be provincial in their tastes. They will have in their abodes the best in ceramics from all lands. It is up to American ceramists to so devise, equip and train as to keep in the front, against all prejudices, at the least cost with the most attractive and serviceable wares without lowering our operatives standard of living. High tariff will not achieve, it merely equalizes, opportunity. Achievements in ceramics rest entirely on facilities in plant and men, both of which must be equipped to produce the best and most attractive at the least cost.

COÖRDINATING CERAMIC RESEARCH

In this day of effort for higher efficiency at lower cost it is well that we consider how all ceramic manufacturers may coördinate to prevent duplication and to make available to all the results of investigations. This question is fraught with many considerations, some human, some social and several entirely fact and business. It would be idle and out of place here, even if it were possible, to show the ramifications into which this question naturally spreads. We shall consider in the following paragraphs only the more essential fact relations involved.

1) Through the past twenty-seven years the ceramic manufacturers and the technical men in ceramics have built up the AMERICAN CERAMIC SOCIETY until it is a going and growing concern. Its size can, perhaps, be better visualized in terms of its $40,000.00 annual budget, its 2050 personal members, 311 corporation members and 273 subscribers to the monthly *Journal*. The fruits of the coöperative efforts of its members is reflected in the 869 pages of original papers, 419 pages of abstracts of the world's literature and 724 pages of practical observations and discussions published in the *Journal* during 1925. Bibliographies, book lists and a Materials Directory were published during the year and the

several committees are compiling and digesting data and information which, when reported, will be of large value alike to all ceramic workers. We cite this SOCIETY first as one of the coördinating efforts of ceramists because, after the National Brick Manufacturers Association, it is the oldest and is now the largest ceramic organization. But the best reason for giving reference to this SOCIETY first is two-fold, (*a*) it is the only organization of ceramists devoted exclusively to promotion of research and education and (*b*) it is the only organization which has succeeded in securing collaboration of ceramic workers from all kinds of industrial ceramics.

2) The several trade associations singly, or in groups as institutes, are engaging in investigations of their production problems. Prior to the joining of the three brick and the hollow tile associations in financial support of a kiln study there had been no collaboration or coördination in technical investigations by trade associations. There is a move now to coördinate the technical investigations of the trade associations through a joint committee, which committee will also serve as advisory to the Department of Commerce. The Clay Products Institute represents the interests of the heavy clay products manufacturers in this move.

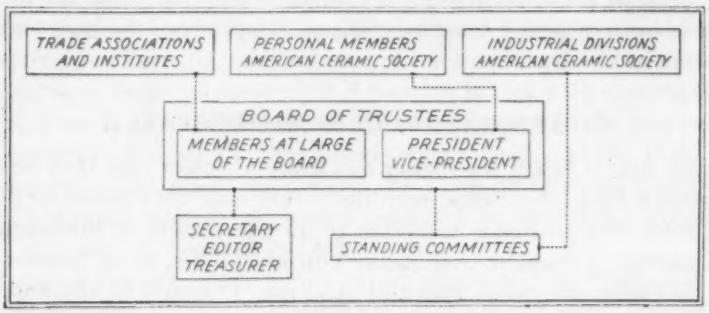


FIG. 1

3) This SOCIETY has recommended a simple and very flexible scheme of coördinating the several trade groups in support of technical investigations, the essential feature of which is joint employment of a Research Advisor and providing him with a cabinet of technical men from the industries.

4) Another suggestion, naturally a corrolary to the one just referred to, is a scheme for coördinating the interest of all ceramic organizations in support of research and education. Diagrammatically this scheme is here shown. (Fig. 1) It is the scheme which the National Terra Cotta Society voted by resolution to consider with the other trade associations.

(5) *a*) Since the AMERICAN CERAMIC SOCIETY (1) is the largest single organization devoted to ceramic research and (2) is representative of all ceramic groups and (3) has proven the feasibility and profit of all ceramic groups working together, and

(*b*) since the total cost of operating the AMERICAN CERAMIC SOCIETY comes from ceramic individuals and corporations, and

(*c*) since this SOCIETY is readily amended in form, there appears no fact nor business reason for all ceramic organizations not joining in making the SOCIETY their medium for collaboration in the collecting and recording of information in ceramic science, technology and art.

6) This coördination would not necessarily change the status, rights or benefits now enjoyed by the individual members, and the Industrial Divisions could continue to function much as at present.

7) The organization here suggested need not finance research or education. It could very profitably continue the clearly defined scope of the present activities of the AMERICAN CERAMIC SOCIETY.

8) If the several trade associations would thus coördinate in making a strong research and education promoting, information collecting and recording organization, the scheme before suggested for financing of research singly or by groups could, but not necessarily need be, coupled with this.

May we disregard all personal and social considerations and plan together for the most economical coördination of the interest of all ceramic groups in support of research and education?

PAPERS AND DISCUSSIONS

STATEMENT ON BEHALF OF EDUCATION COMMITTEE

By W. K. McAfee

The Educational Committee of the American Ceramic Society does not wish to be considered critical in regard to ceramic education as now offered in our various ceramic schools. There has, however, been some criticism, and the Committee's object is to promote as much discussion and constructive criticism as possible, and to do everything it can to further coöperation between the schools and the users of their product.

The discussion following deals largely with the ceramic engineer and technologist rather than the pure scientist or the ceramic artist. The question of how much specialization there should be in a four-year course is a difficult one, and is by no means confined to the ceramic branch of engineering education. Engineers going into the heavy clay products branch of the industry need a more thorough grounding in mechanical engineering. Engineers who go to work in electrical porcelain plants should have more electrical engineering than is necessary for general ware, for instance.

How soon in his college career should a ceramic engineer choose the branch of the industry he will go into? The administrations of many of our universities and colleges are requiring more and more academic studies for engineering graduates. This reduces the amount of time that can be devoted to technical studies, and makes it harder to give the students everything they may need when they get out of college. Perhaps it is better that some of these courses which promote better citizenship be given in college instead of high school. If this is so, should not some preliminary work be done on ceramics in the secondary schools? If the student must choose the branch of the industry he is going into early in his college career, he would be able to do so more intelligently. A special preparatory course for collegiate ceramic engineering is being conducted in East Liverpool, Ohio, in connection with the vocational school. We shall watch with interest the graduates of the course when they enter college.

The questions which we hope will be raised at this meeting are broad, and it was not our thought to discuss at this time the arguments for and against the several subdivisions of ceramic education suggested above. The specific question raised now is whether or not more emphasis should be placed by our schools on the characteristics of the finished product.

---

[1] Presented at the American Ceramic Society, Fall Meeting, New York City, October 1, 1925.

All manufacturers have to meet increasing competition, not only from other manufacturers of the same product, but also from other products that may be substituted. It is becoming more and more essential that we make the best possible ware for the purpose for which it is intended. Lowering costs is important, but the ceramic executive today is mostly concerned with the quality of his product. Should the undergraduate ceramic engineer not be trained to think along this line? Should he not be taught this kind of thought habit?

Suppose, for example, the question of substituting one material for another is under consideration. The new material is tried in the glaze, and found to work well and give a good appearance. The main point deciding for or against the substitution in many types of ware, should be: will the new material make the glaze harder or softer, and if softer, will it still be hard enough to give satisfactory service? Most ceramic graduates could easily make the substitution, but how many would think primarily of the hardness of the glaze? In many cases, of course, the proper hardness could not be definitely determined because specific specifications have not yet been developed. This, however, is the problem of the different trade associations, and one in which they will need the help of ceramic engineers as well as ceramic scientists.

Take another example. Suppose that a manufacturing difficulty arises in making a high tension insulator, and a slight change in shape eliminates the trouble. The main consideration should be: does it raise or lower the flash-over voltage, and how does it affect the mechanical strength of the piece? If either, or both, are lowered, does the desirable factor of safety still exist?

The teaching of thought habits that will give the graduate this point of view seems to the Committee to be worthy of a full discussion.

CAMBRIDGE SANITARY MANUFACTURING CO.,
CAMBRIDGE, OHIO.

OPINIONS OF A FACTORY MAN ON CERAMIC EDUCATION

BY CHARLES W. HILL

Introduction

The discussion of ceramic education by those concerned with the ceramic industry may be of some value in indicating to those in charge of ceramic courses the need of training along certain lines. It is possible that by such discussion the industries may benefit by being able to secure graduates better equipped for the solution of their problems,

[1] Presented at the AMERICAN CERAMIC SOCIETY, Fall Meeting, New York City, October 1, 1925.

while the colleges may benefit by the creation of more situations for their students. It is true that in certain subjects (as for example chemistry) the teaching for years was along lines for which the demand for new men was limited, and the training given the students was not such as to facilitate their working into situations of greater promise and compensation. If the opinion of the industrial men can be crystallized and expressed in a practical way it may serve to prevent ceramic education from experiencing some of the unsuccessful results in other technical lines.

In the last analysis, of course, the application of suggestions made by the laity must be left to the director of each college course to work out according to the local facilities or limitations. It must be appreciated that in addition to limitations of equipment and endowment there is in almost every college a serious difficulty in securing the instruction in other departments which is best adapted to the student of a particular technical course. Thus, it is difficult to secure a presentation of chemistry for students of ceramics as distinct from that for mechanical engineers, agricultural students, medical students, etc. This difficulty applies to the subjects given by many other departments. The chemistry department in any one of our colleges where ceramic courses are given would doubtless be glad of the opportunity to offer courses especially adapted to ceramic students, if the department appropriation were sufficient to provide for the extra instructional force required. This practical limitation found in all colleges is perhaps one of the most serious obstacles to educational advancement in technical lines.

The Ceramic Field

At the beginning let us outline briefly the various types of work which may engage the services of men trained in ceramics. These are in general five, *viz.*, research, factory laboratory, technical control, factory management, sales.

Research The Bureau of Standards, Bureau of Mines, Mellon Institute, manufacturers' associations and a few of the larger manufacturers conduct research on materials and products of a somewhat recondite nature. It is extremely doubtful if a four-year course in any subject is sufficient for research work of the highest type. For this work it would seem necessary for the student to take two to three years of graduate work in chemistry and ceramics following four years of general scientific training. As most of the preparation for this work involves other courses than ceramics we need not consider it in our discussion.

Laboratory This involves development of glazes and bodies for specific products, clay testing, etc. It has been the main objective apparently of most of the ceramic training of the past. The graduates

as a rule have been able through empirical methods to provide for factory requirements. There appears to be some evidence of failure on the part of the colleges as well as the graduates to develop a more scientific approach and control of both glazes and bodies. There would appear to be an opportunity to develop more accurate methods of studying glaze and body mixtures and of determining their values and properties, at least for the purposes of preliminary investigation, by more rapid means than trial batches fired in regular factory kilns. It is, of course, realized that the problems are involved on account of many variables in materials and processes and by the fact that equilibrium is not obtained in the typical ceramic reactions.

It must be said in all justice that many ceramic establishments keep their ceramic laboratory force either too small in number or keep it too busy on routine work to permit of much work on new developments. In some cases they fail to surround the ceramist with suitable apparatus and equipment.

The ceramic manufacturer certainly is not entitled to expect the colleges to turn out graduates able to answer the endless questions and problems incident to a specific process or product from the training and limited experience of college without proper time and equipment for careful and exact experimentation.

Factory Control For some peculiar reason many ceramic graduates appear to lack interest in factory control of materials and process used in regular manufacture and fail to be on the alert to suggest improvements or economies. There is, of course, an element of routine and sameness in this line of work and yet there is probably no other field in which the ceramist may show his value to better advantage. In ceramic as well as chemical lines, this work frequently furnishes the bridge between purely technical work and that of the executive and paves the way for personal advancement.

With notable exceptions, there appears to be a tendency on the part of a large proportion of ceramic graduates to become laboratory recluses. This is in rather striking contrast to the mechanical or chemical engineers who are frequently prone to want to revolutionize the factory and the methods. The tendency is so marked that one wonders if the nature or emphasis of the college training in ceramics, in some of the colleges at least, may not in some way be partly responsible. Be that as it may, there is a crying need for technically trained men in the factory as contrasted with the laboratory. Men are wanted who not only know the science of the material, process and product but who prefer to be out where the wheels are going around or where the kilns are on fire rather than in the laboratory.

Factory Management

It is the opinion of the writer that the ceramic industries will not reach their highest development financially and otherwise until ceramists are found in large numbers in subordinate as well as higher factory executive positions. It would seem that there exists a vicious circle. Many manufacturers think they cannot afford to pay the salary necessary to hold a ceramist as foreman or superintendent when a ceramist of the engineering type could doubtless show a good profit on his employment and might even be the source of giving the profit necessary for larger scale operations. It is, of course, significant that a large per cent of ceramic establishments taken as a whole are rather small and have limited if not uncertain financial structures. The tendency has been to concentration to limited lines of ceramic manufacture. We have no ceramic companies of the size or with the varied line of manufacture found in other industries. There seems to be a feeling among some ceramic manufacturers that it is necessary to have the very large company first before the luxury of a technical organization can be afforded. Unless ceramics is different from many other lines involving chemical processes, the proper technical organization would assist materially in turning the small company into a larger one. It would, of course, be true that a company so insufficiently financed that it could not increase its capital investment by needed and profitable improvements could not derive a profit on a very large technical organization.

However, improvement of equipment and processes has marked the advancement of other lines of industry and unless our industry is essentially and fundamentally different from all others there will be an increasing demand for the technically trained man in factory executive positions.

Our ceramic education should not only give the training for this kind of work but should lead the students to appreciate the opportunity which they may be able to find or create, if they are sufficiently alert.

Perhaps some element of selection is needed on the part of the college. For this opportunity men are needed who not only have the personal characteristics required for industrial leadership but who are intensely interested in production, men and management. To use the vernacular, they should have something of the "rough neck engineer" in them. They should be able not only to "mix" with the factory men but to enlist their voluntary coöperation. Probably the ideal factory type of technical man is not likely to be attracted to ceramics in college if he thinks ceramics is largely a matter of laboratory experimentation. There is an opportunity for ceramic colleges to sell their course to this type of student by stressing the human and the production side of ceramic manufacture rather than slips and glazes.

Like the opera singer, salesmen are probably born and not made. Selection is probably more important here than in factory executive work. The demand for salesmen especially trained in ceramics is probably not great, since an organization with a good ceramic department can, in conjunction with the sales and manufacturing departments, train salesmen to sell products or equipment. There is apparent, however, a certain drift of ceramists into the sales end of several lines.

Sales

Present Courses

Having discussed the various lines of ceramic work let us attempt to gain a general idea of the courses now offered to students in ceramics and consider the value of the various courses as a means of preparation for active commercial work.

A summary of five of the leading courses in ceramics is given below, the hours being reduced to credit hours per year with laboratory units figured as 3 to 1.

	A	B	C	D	E	F
English	6	15	6	6	6	6
German and French	12	12	8	6	10	14
Mathematics	20	20	20	20	20	16
Physics	16	14	10	10	10	8
Chemistry	26	25	23	16	15⅓	34
Ceramics	22	29	40	26⅓	42⅔	36
Engineering	10	17	14	17⅔	16⅔	
Mineralogy and Geology	6	10		2	1⅔	13⅔
Economics		3		8		
Shop				1⅔		
Drawing	6	4	8	7⅓	8	6
Surveying						
Elective	18		14	12	6	12
Thesis		4	3			
Civics	2					4
	144	153	146	133	146⅔	149⅔

English

With one exception, which provides a second year of English literature all courses are limited to one year of English. While there is no doubt that a longer study of this subject would benefit the ceramic student, we shall probably have to content ourselves with the three-hour course for one year and use the valuable time for more technical or utilitarian subjects.

German or French

Certainly if German or French is to be included in the ceramics course, nothing less than two years should be given. It is doubtful whether two years will give the student enough familiarity with either language to enable him to use

it even to the extent of reading it easily. It would seem better to increase these subjects to three years or substitute something in their place. There may be some doubt as to the advisability of including a modern language in the four-year course for ceramists or ceramic engineers who are to go into commercial work. A student who intends to engage in research would require a full course in both French and German.

Mathematics There can be little question as to the desirability of the amount of mathematics included in all the courses. The presentation of the mathematics courses as given in engineering colleges is doubtless more suited to the future needs of our students than those offered to liberal arts students. In other words, less emphasis should be placed on mathematical theory and methods and more on repeated practical applications in the shape of problems.

Physics The benefit of a full course in physics seems to be generally appreciated. The training in exact methods of measurement and a full understanding of the theory of errors as afforded by a full laboratory course should not be slighted or omitted. The every day applications of the theory of errors seems to increase as one grows older in industrial work.

Chemistry It is unfortunate indeed that this important fundamental subject is not presented in a manner most suited to the needs of ceramic students. It is necessary to accept the chemistry courses as one finds them for the present and hope for the day when each ceramics department has influence enough at court to secure special attention for its students.

General chemistry might well be a full five-hour subject without the introduction of qualitative analysis in the first year, necessitating the exclusion of some of the subject matter of general chemistry.

Qualitative analysis is of value as a review of general chemistry and the practical value of this course is frequently proven by the student in later years.

Quantitative analysis as usually given is wasteful of the student's time. Instead of working laboriously through a series of unknowns it would be much better to teach manipulation of all the processes used in analytical results. It would be a remarkable ceramic graduate indeed who could make a reliable analysis of even simple substances, not to mention the complex clays and minerals with which he works. The wise ceramist has his analytical work done by a reliable commercial laboratory. On the other hand he should be able to handle the operations of analytical chemistry both in gravimetric and volumetric analysis.

This is the real chemistry after all and a subject in which many ceramists now wish they had received more training. Modern developments show an ever-increasing application of the laws of physical chemistry to ceramics. Here again it is unfortunate that many of the typical laboratory experiments which are of great value to the chemist could not be omitted for the ceramic student and others substituted which have a more direct bearing on his future work. Advanced courses in colloidal chemistry and thermodynamics should be included at least as electives in colleges where they are offered.

Physical Chemistry

Gas and Fuel Analysis The more simple methods of gas and fuel analysis and the features of sampling, calculation and interpretation of analyses should be given the ceramic student.

Ceramics It is difficult to determine the true value of a course or of a single subject as offered by a college from a study of the catalogue. A course may appear to be thorough and of value but may be given by one who is not an authority on the subject or the so-called laboratory course may be a very poor excuse. Many a ceramist who has been successful owes a debt to the influence of a great teacher, regardless of the title of the course he was supposedly teaching.

As new courses were developed in the past, breaking away from the old time A.B. course with its Latin and Greek, and as these courses became more highly technical there was the tendency if not the practical necessity to "pad" the course. As the branch of science developed the courses became more condensed and "meaty." Some of the ceramic courses given today show evidence of the early days and probably could be revised to the ultimate benefit of the students. Thus it might be well to remove from lectures and classroom work a considerable part of the general and qualitative features of ceramics which can be covered by the student in collateral reading followed by quizzes or examinations. This would leave the valuable time of the lecture or recitation for development of the quantitative and scientific features of ceramics. This would seem to apply particularly to the subject of clays, classification, occurrence, mining and preparation.

It was the writer's intention to subject the various courses to careful analysis as to the subject matter and time devoted to purely ceramic subjects. On account of the different grouping of the same subjects, different proportions of time devoted to lecture and laboratory and differences in units as well as the condensed descriptions of some of the courses, this was found to be impracticable with the information available.

The general outlines appear to be about the same, including the following: clays, bodies, glazes, drying and firing, kiln and plant design,

calculations, pyrometry, refractories, glass and enamels. A comparative study would doubtless reveal superiority of certain schools in equipment and in number of teachers offering separate subjects. The general outlines if properly carried out would seem to cover the ceramic field quite satisfactorily.

Engineering It is pleasing to note the amount of time given ceramic students in some colleges in engineering subjects. This is especially acceptable to one who believes there is a real future for ceramic students in the factory after a laboratory experience.

Among the engineering courses given in the various colleges we find: analytical mechanics, mechanics laboratory, resistance of materials, power measurement, machine shop, heat engines, elements of electrical engineering, forge and foundry shop, roof stresses and trusses, power generation and transmission and surveying.

Mineralogy and Geology Certainly an elementary course in geology should be included in any ceramic course; but it will be seen that there are great differences in the amount of time devoted to geology by the individual colleges. Probably it would be better to induce those students who are particularly interested in clay mining and preparation to take an advanced course in geology as an elective, and limit the scope of the required course.

A certain amount of mineralogy would be of value to ceramic students. Unfortunately it is difficult to get special attention to these students by a separate department. It may be questioned whether a full course with the usual stress on heavy metal minerals is of enough value to pay the ceramic student for his time. It would seem that a good course in optical mineralogy should be one of the required courses but specific reference to such a course was not found in any of the ceramic courses although in some cases it is offered by the college. One college requires a course in thermochemical mineralogy which from its description would appear to be a very acceptable addition to any ceramic course.

Drawing The necessity of a familiarity with drawings is recognized by all the colleges which give approximately the same time to this subject. The course should include mechanical and architectural drawing.

Elective The opportunity for electives varies from none at all to eighteen semester hours. Certainly a course should provide a liberal allowance in electives, but these should be carefully selected under the direction of the head of the department. Students who anticipate going into production should be encouraged to elect some of the following: economics, labor problems (piece work) scientific

management, accounting (general and cost) business administration, business law, contracts and specifications, and transportation.

A student who is especially interested in terra cotta manufacture would do well to elect one or two elementary courses in architecture. Specialists in various ceramic lines will doubtless have other electives to suggest. Thus the enameled ware manufacturer might suggest to the student the desirability of knowing something about iron and steel, heat treating, annealing, etc.

Thesis Four of the colleges require a thesis, but the credit given is low. It is extremely doubtful whether it pays to attempt a thesis for undergraduates. There is not sufficient time to accomplish much in the way of original investigation. In place of the thesis it would seem better to select some of the electives suggested above or the seminar in ceramic literature mentioned later.

Inspection Trips Inspection trips and summer work are invaluable. A very important value of factory inspection trips is the awakening of the student's interest in a specific industry. This increases his application and may be of value to him in the selection of elective courses.

The following is suggested for consideration as a part of the required course:

Ceramic and Chemical Literature The ceramic student should be familiar with the journals and books not only in ceramics and chemistry but in other lines in which he may sometime be required to search for information. Either as a part of this course or as a seminar it would be valuable to assign to students for review important journal articles not necessarily current. By proper selection, the students may learn to recognize careful and scientific research and learn something of proper methods. On the other hand, by referring to papers of doubtful value or those lacking in proper attack or control, their powers of criticism may be developed so that they may learn to evaluate as they read.

Properties of Industrial Products

Discussion has been invited of the question whether ceramic schools should not devote more time to the properties of ceramic products and the relation of these products to the service for which they are intended.

The desired properties of ceramic products in many cases are determined by the equipment or processes in which they are used. Changes in these necessitate changes in the ceramic properties desired, and these changes are taking place at frequent intervals. There is frequently a period of trial and experimentation in which the desired properties

are not determined. For the colleges to keep abreast of the changes occurring over the broad field of ceramics would be difficult if not impossible.

In many lines the exact relations between properties and service are not established and are the subject of investigation by manufacturers or by trade associations.

In general it may be said that the relation between properties and service involve intricate problems in other branches of science than ceramics. A careful study of these properties may involve physics, chemistry, mechanics or electricity. The ceramic student cannot be expected to be an expert in all these highly developed lines. In a great many cases the study of the relation under discussion calls for highly trained specialists in other lines.

The relation between physical properties and industrial use of many products not only involves special training to a marked degree in subjects other than ceramics, but it may involve apparatus which only a very large company or association would be justified in purchasing. This type of work can probably be handled best by such organizations as the Bureau of Standards, Bureau of Mines, Mellon Institute, etc., and financed by trade associations.

Finally the study of any one product in this respect would require a most thorough knowledge of materials, processes and product. At best, an individual student in the time permitted by his other studies could learn something of these relations for one specific product, as for example, spark plugs, porcelain insulators, glass tanks and blocks, fire brick, sanitary porcelain, tiling or terra cotta. If he were fortunate enough in securing employment in the line in which his study was made he would doubtless make more rapid progress at first. If he were not so fortunate he might never use the information gained.

The specific nature of the problem as shown above requiring the expenditure of too much time on an individual problem is not only objectionable for this reason, but is contrary to the best principles of college education. The aim of ceramic education as afforded by the regular four-year course should be to give the student the fundamental background of science, mathematics and ceramics; to teach him orderly methods of thought and experimentation, and to give him confidence to sail his ship into unknown seas of ceramic industry; but it should not attempt to make him a specialist in any one branch of ceramic industry.

The writer feels, however, that more emphasis should be placed on the methods of determining the physical properties of ceramic products and on the relation of composition and treatment to physical properties. These relations should be developed quantitatively and mathematically. In this connection one cannot help being struck by the fact that ceramics

has almost no general laws or formulas similar to those in physics, chemistry and mechanics. Ceramics is still largely in the empirical or "cookbook" stage, having evolved through that of superstitition and "alchemy." Many of the simple properties are not tied up quantitatively with the materials used. To illustrate: given the shrinkage and porosity of the components, how may the shrinkage and porosity of the resultant products be calculated?

If ceramic courses develop to the point where five years are desirable as appears to be the case in chemistry and some branches of engineering, the inclusion of such studies in the fifth year would doubtless be worthy of consideration.

General Aims of Ceramic Education

There is one feature of ceramic education as in all other technical education which those engaged in educational work should ever bear in mind.

There is a tendency so strong as to become a temptation for the instructor to give his student so-called "good practical dope." Aspersions have been cast upon college education and college professors by many successful self-made men, usually of the purport that college professors are too theoretical and not practical enough to be of any use outside of college. The old phrase of "he who cannot, teaches" is still handed around. It is, therefore, perhaps natural that many professors in technical lines who have had commercial experience are prone to stress the practical side in self defense. While general theory should be tied to the hitching posts of practical applications and practical problems, the mistake should not be made of giving specific information of limited usefulness as a part of general information or teaching.

This is not only a cruel waste of time but it has a bad effect on the students. They are ever on the alert to pick up something which they can immediately use when they go to work. They instinctively look for a "crutch" or a "crib" to take along with them to their first job.

"Practical dope" as the students term it is a deadly drug although the popularity of professors dispensing it is sometimes pleasing to them if they are unable to appreciate the proposition of general training and fundamental principles. There is perhaps no field where formulas and figures are so useless as in the compounding of glazes, slips and ceramic bodies. The materials used being natural products or mixtures of varying composition purity and fineness are not fixed in their properties. The ceramic student must be made to be self reliant, to go back to fundamentals on all his problems and to attempt to use the results of others only so far as they represent general properties, processes or methods.

A Word to Manufacturers

If one were certain that manufacturers, *i.e.*, manufacturing executives, would read these notes one might be justified in devoting some time to comment on the subject of what may reasonably be expected from young graduates: how they should be further trained in the industry, what support they should be given not only by provision of suitable equipment, but in backing before the factory and executives.

When one secures a new machine or product he naturally studies carefully the accompanying instructions or directions. It sometimes seems that colleges should accompany their graduates with similar explanatory literature, for many a failure of the new graduate has arisen largely from his treatment or the use which was attempted to be made of him. However, as Kipling says "That is another story."

Conclusion

In comparison with other technical courses few apologies are needed for those in ceramics. Without doubt improvement can be made in the courses themselves, possibly along some of the lines discussed above. Graduates of ceramic courses can assist by informing their former teachers of problems which they have met in practice and for which they were not given adequate preparation in college. The ceramic industries can assist ceramic education not only by donations and scholarships, and by opening their factories to student inspection trips, but by a better reception and coöperation with the ceramist in their own organization whether it be a new graduate or one of the old faithful graduates of years gone by. The encouragement and support of the ceramist in research work and the permission to publish his results are not always given fully or freely. The restriction of contact with other ceramists or discussions with other ceramists is seldom a commercial necessity.

The ceramic professor should arrange to visit various ceramic plants at intervals and should not become a recluse. While he may be met with attempts to secure consulting advice without the usual fee, it is probable that his visit will profit him personally quite adequately for any gratuitous advice he may give.

METUCHEN, N. J.

CERAMIC EDUCATION AS APPLIED TO THE REFRACTORIES INDUSTRY[1]

By M. C. Booze[2]

If we may judge the importance of the ceramic industries by the value of goods produced, it is evident that these industries hold a high position, and on this basis a serious consideration of methods of ceramic education is well deserved.

The fact is not generally appreciated that ceramic products equal in value the pig iron produced yearly, and exceed that of all the non-ferrous metals.

Technical training in subjects related to many industries of less economic value than ceramics was included in the curricula of colleges and universities years before the first course in ceramics was offered, and it is not surprising that the educational methods of ceramic departments do not produce men as well fitted as in other branches of science.

Attempts by educational institutions to cover the whole field of ceramics in four-year courses have also militated against the production of graduates properly trained to meet the needs of the various branches of the industry. The problem is further complicated by the fact that the student must have a basic foundation in chemistry, physics and engineering subjects.

The most evident weakness of a ceramic graduate when entering upon the work of a particular branch of the industry is his lack of specialization and unfamiliarity with the problems he has been engaged to work upon. This is especially true with regard to manufacturing methods, properties of the products and their uses.

In the refractories industry, this weakness is particularly noticeable. A knowledge of raw materials, such as the graduate has, is of some value in maintaining uniformly high quality, but in the majority of cases the plants are so situated that selection from a wide variety of materials is not possible. He is not versed in the problems of manufacturing economy, development of products and their application for specific purposes that are of first importance and capable of being solved satisfactorily at each plant.

The ability to develop refractory products for specific purposes or to make proper application of the products at hand requires a knowledge of their properties and of the furnace conditions under which they must serve. The graduate must understand the relation of structure to slag

---

[1] Presented at the American Ceramic Society, Fall Meeting, New York City, October 1, 1925.

[2] Senior Fellow, American Refractories Institute, Multiple Industrial Fellowship, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

erosion and spalling, the differences in properties of hard and soft fired brick and of those made by different manufacturing methods. He should be familiar with methods of testing and able to interpret the results in terms of serviceability.

The importance of such knowledge can be appreciated when the various types of refractories are considered. Aside from their chemical properties there are extreme differences in products made from silica, chrome, magnesia, silicon carbide, zircon, diaspore and clay. Yet a study of the raw materials alone will not in most cases bring out these differences, and it is only by experimentation with the products, subjecting them to test and studying their behavior under different conditions that a true appreciation of their properties is had.

It may be said that it is not within the province of a ceramic engineer to study the operating conditions within furnaces where refractories are used. It would seem that the furnace operators should have all such information necessary. While it is agreed that these arguments are logical, it is also true that the desired information is not available and refractory technologists are finding it necessary to make detailed studies of these service conditions. Since this is found necessary, the matter should be given some attention in the course of instruction.

It is realized that thorough instruction in the subjects mentioned could not be given within a four-year period, in addition to the subjects included in the regular ceramic course. In order to properly train the student for one branch of the industry, it will be necessary to extend the course, or to require him to specialize. The latter procedure appears to be the logical one to follow.

EXTENSION WORK IN CERAMIC ENGINEERING[1]

By Arthur S. Watts

The fundamental idea of university extension education is that the knowledge obtainable at the university shall so far as possible be made available to those who cannot attend the university.

This idea has been most highly developed in connection with agriculture and today agricultural extension service is available to and enjoyed by agriculturists throughout the country. The value of this form of educational service can hardly be over-estimated and has yielded results which more than repay the annual investment.

University extension service in engineering similar to that provided in agriculture has been undertaken in a number of states but not in

[1] Presented at the American Ceramic Society Summer Meeting, Toronto, July 9, 1925 and Ohio Ceramic Manufacturers Association, Annual Meeting, Nov. 20-21, 1925,

exactly the same manner as the agricultural extension service, due to the difference in the nature of the problems to be met.

The dissemination of knowledge by extension service has been through published information, lectures and demonstrations to interested groups, and by correspondence courses. Practically the entire country has been organized in order to secure agricultural extension service most effectively and economically, and the same system must be employed if engineering extension service is to be equally successful.

The first step in the development of agricultural extension service was the Agricultural Experiment Stations, where the problems vital to that industry were studied and bulletins published and distributed setting forth the information obtained. This same step was the first development in engineering extension and until 1910 was practically the only form of engineering extension work attempted.

In 1894 the University of Wisconsin issued its first Engineering Bulletins which made the results of researches at that University available to the general public. In 1904, the University of Illinois published its first Engineering Bulletin. Prior to 1910 these two were alone in promotion of engineering extension work and the University of Wisconsin was alone in providing extension courses of study in engineering. Today many state universities have some form of extension service, which include short courses, technical institutes, correspondence study courses, evening classes in industrial centers, package library service, technical lectures and conferences, visual instruction service and engineering publications. In some institutions this branch of service has become a very important factor in the engineering department, *e.g.* University of Wisconsin and University of Minnesota have large engineering extension faculties. They offer nearly every course for which a textbook can be provided, and many other courses are taught by combination of visual instruction (moving pictures) and lectures. In industrial or commercial centers these Universities have organized extension districts with instructors in charge.

These universities also provide group study systems, with personal visits and instructions from professors and specialists in addition to correspondence instruction. Students who pursue these courses of study may take examinations and thus obtain credit at the University for the course completed.

The offerings of the extension departments have been chiefly in civil, mechanical, electrical and architectural engineering. Prior to 1924 the only extension work in ceramics was given by Iowa State College which offered ceramic lectures to groups when requested to do so. In 1924, North Carolina State College announced a series of correspondence courses in ceramic engineering covering fourteen different subjects,

which include practically every ceramic course now given by lectures in the universities, with the exception of "Bodies and Glazes." These correspondence courses are available to anyone who pays the fees, but if university credit is desired the student must meet entrance requirements and also pass an examination when the work is completed. If no credit is desired no examination is necessary. The tuition is based on the college equivalent of one lecture per week. Most courses represent 3 lectures per week and the fee is $7.50 or $2.50 per unit.

This College limits the student to two courses at the same time and urges that only one course be attempted at a time. No prerequisites are assigned to any of the courses except that in ceramic designing which calls for a course in mechanical drawing. Correspondence courses in ceramic engineering are thus available when desired and until the call for this class of instruction is sufficient to make duplication practical it would not seem advisable to offer similar courses elsewhere.

The greatest difficulty with the teaching of all engineering courses both at the universities and in extension work is the fact that a great majority of students are seeking facts and values rather than the education by which they may determine for themselves the facts and values sought. Every teacher is frequently confronted with requests to take advanced courses without the elementary courses which precede them. The student wants to learn the advanced science without the fundamentals, on the assumption that the fundamentals will somehow become apparent as they are needed.

In every freshman class in engineering we find a number of students with good minds who become discouraged and leave the university because they cannot become interested in the fundamental subjects which constitute the curriculum of the first years. The correspondence courses as given by many institutions have been abandoned by students in a majority of cases because of the same objection. It is apparent to all educators that students are of two classes (*a*) those who desire education which shall give them command of their entire field of activities and (*b*) those who desire only the knowledge essential to a successful operation of some special process.

Attempts to supply the latter through special lectures, short courses, and special classification in the universities have been very discouraging and I am convinced that this class constitutes the vast majority of those to be reached by extension service. How can this service be provided most successfully and economically?

The correspondence courses have great merit for those who desire fundamental knowledge of any given subject and are strongly recommended to those who desire general education but could not be devel-

oped into a special course for each student without an enormous increase in the cost.

The short course, or two weeks course, at the university must, in my opinion, be considered either as an inspiration to the student causing him to take increased interest in his work or as a contact opportunity whereby the educated man may brush up on his training.

I seriously question whether 5% of the students who attend a two weeks short course without any preliminary training are able to use in their business any specific knowledge gained there. This does not mean that the short course is not distinctly worth while. It is enormously valuable in a broad educational sense but must not be considered as a means of obtaining the "meat out of the cocoanut" as many people imagine. If the students assembled for a short course had spent the previous months in correspondence study preparatory to the course, the results would be very different.

Technical lectures in interested industrial centers if provided on a small scale would doubtless be of enormous value as an inspiration to the students attending but could not furnish more than a contact supplemental to some other system of instruction. If evening classes could be supplemented by such technical lectures the result would, I believe, be very satisfactory.

Technical institutes either at the university or in interested industrial centers would undoubtedly be the most fruitful method of transmitting knowledge to those who are already well grounded in the fundamentals or at least have an industrial understanding of the processes to be discussed, but for the beginner they would have relatively small value.

The utilization of the engineering experiment stations for conducting investigations, the results of which are to be made available to the industries are in the same general class as the technical institutes. This form of extension work would be very valuable to the industries, but would have little value to any but advanced students.

From the foregoing, it is apparent that engineering extension work is of two kinds: *viz.*,

(1) The furnishings of educational opportunities of university grade to those who cannot attend the university.

(2) The furnishing of advanced technical knowledge to those who are equipped to receive and use it.

While these could both be developed in the same institution, the equipment would be widely different, and there should be a definite understanding as to the form of service desired before any attempt is made to secure extension service.

This is especially true in attempting ceramic engineering extension work because if the original service provided does not become popular

and have the support of both the industries and the citizens, it will be impossible to secure any additional service. In my judgment the greatest service would be obtained from ceramic institutes and published ceramic information obtained by research in the engineering experiment station.

These institutes would permit technical and industrial ceramic men to meet and discuss their problems and to such institutes the state would be justified, I think, in furnishing technical lecturers. The information accumulated at such an institute could be compiled and published as an engineering bulletin. If each institute held had one definite industrial subject for consideration and had the enthusiastic support of the industries and their personnel, in addition to the technical contributions from the university, these bulletins would be of great value as ceramic educational literature.

The conducting of ceramic research by the engineering experiment station and the publication of information thus obtained, would, if the problems were wisely chosen, contribute additional ceramic educational literature and these two phases of ceramic extension could work together to the advantage of both.

Neither of my proposals would contribute to elementary ceramic education because I do not feel that the teaching of elementary ceramic engineering of university grade by extension methods is as great a need as the assisting of industrial individuals in the study of real industrial problems.

If extension service to the ceramic industries is desired and the initial service is successful, there is no doubt but that the scope of the work would be rapidly increased.

I recommend that a committee consisting of representatives of every type of ceramic industry be created to consider what form of ceramic extension service is most needed and to make recommendations to this association regarding such service and the methods to be employed in securing same.

LORD HALL, O. S. U.,
COLUMBUS, OHIO.

SHOULD PRODUCT AND PRODUCT REQUIREMENTS BE STRESSED MORE IN SCHOOL CURRICULA?[1]

BY AMOS P. POTTS

To the layman this question must have two apparent sides or it would not have been taken as a subject for discussion; and the writer, who, having practiced the profession of ceramic engineering for some

[1] Presented at the AMERICAN CERAMIC SOCIETY, Fall Meeting, New York City, October 1, 1925.

thirteen years and could scarcely be classed as a "layman," can also see two answers to it but to his mind these answers are not of equal weight.

Naturally the question may be answered "yes" or "no" and in view of what has just been said may be answered, "yes and no."

The affirmative answer is the popular one.

Of course, the ceramic technologist should know something of the properties and specifications applying to ceramic products and as the school curricula are designed to train ceramic technologists, such training should be included in the curricula. This is so very evident that it seems almost beyond controversy. However, there are other matters beside the one under discussion which should be similarly included, as for example, heating and ventilating as applied to drying, geology, economics, electrochemistry and petrography. They are not included and the reasons for their exclusion should be examined as to their sufficiency.

In order not to ramble too far afield, we shall endeavor to confine ourselves to the one subject in hand. But we shall narrow it down to "Why are products and product requirements not included in school curricula?"

The school curricula are designed to train men for service as technicians to the ceramic industry in the expectation that these men or a majority of them will do engineering work if they do not actually become ceramic engineers. Therefore, in designing ceramic courses a definition of ceramic engineering must be kept in mind, as we are planning a course to train men for this field. The writer assumes that the accepted definition is as follows: the application of science to the ceramic industry. A course designed to meet the requirements of this definition would contain work in all sciences that might possibly be used in or applied to the ceramic industry together with a description of the industry itself and the various processes involved, showing the applications of science which have been made and the weak points, or points where further applications of science might profitably be considered.

It is obviously impossible to cover this field or even a considerable part of it in four years of forty weeks of forty-four hours each. In the first place the student must acquire a considerable knowledge of the fundamental sciences before he can proceed to a consideration of the application of science. Then his mind must be trained in scientific thinking. All of this takes time, in fact, two of the precious four years have generally elapsed before the student has acquired the necessary ground work to warrant spending time considering the industry in its scientific phases.

Now it must not be considered that the ordinary course consists of two years of general science and scientific training, followed by two

years of study of the ceramic industry, its ramifications, products, raw materials and processes. Two years would not be too much time for such work but unfortunately they are not available. In fact, not more than one-half of these two years are available for this work. An actual analysis of the various curricula indicates that the time allotted for purely ceramic work varies from 25 to 35% of the total four years and much of this variation is due to variation in school organization and description of courses so that less than one-third of all existing four-year undergraduate courses are strictly ceramic work. This is unfortunate but it cannot be avoided, at least until such time as engineering schools become graduate schools and a B. Sc. or B.A. degree becomes an entrance requirement.

The problem before the faculty now becomes what can we give the student in one-third of four years work that will start him on the road of greatest service to the industry upon graduation.

The faculty quickly recognizes the part that the newly graduated ceramist is to play in industry as well as the part which he will not be called upon to play.

Many firms have taken young graduates just out of school and expected the same quality of service from them that they would be fortunate to get from a man with ten or twenty years of factory experience. But they would not do the same with a doctor or a lawyer and should not with an engineer.

Therefore, if it is impossible to turn out a finished engineer in four years of collegiate work, are not specifications for products rather non-essentials? Would the graduate and his employer not feel that a course describing minutely all of the products produced in the ceramic industry had consumed time which might far better have been devoted to processes and materials and their combinations?

Especially will this be so when it is realized that the raw materials have so vital a part in the properties of the products and the consumer in the normal buyer's market writes the specifications.

There is yet another valid reason why such a course should not, at this time, form a part in the undergraduate work and that is the lack of standard specifications, the Bureau of Standards, the Tariff Commission and the American Society for Testing Materials, have been working for years to establish such specifications and those that have been established are available to anyone who will take the trouble to look them up. But there is a very considerable and important field which has not been covered and from the results obtained to date, bids fair to defy standardization for some time to come. Such a condition is not favorable for undergraduate work as it tends to weaken the students' confidence in the rest of the course.

We have seen that the reasons for exclusion of this subject from existing curricula are the lack of time, the lack of standards and the lack of value of such a course to the technician. These reasons are good and the writer believes sufficient so far as undergraduate work is concerned.

When it comes to the graduate schools, conditions are somewhat changed. The problem of the graduate student is different from that of the undergraduate. He has a definite aim for his advanced study. He has practically completed his cultural training and his study of general science. He is preparing to become a specialist and if he elects to devote part of his time to studying the properties of some or all ceramic products, either for the purpose of increasing the available standard specifications or improving existing standards or merely for the purpose of obtaining a knowledge of existing specifications, every facility may profitably be placed at his disposal as the dissemination of such information cannot but help the industry by showing the consumer what he may expect in the way of compliance with his specifications and the relative value of materials departing but slightly from the specifications under which he proposes to buy.

CLAY PRODUCTS COMPANY,
BRAZIL, IND.

AMERICAN CERAMIC ART SYMPOSIUM[1]

It seems that the keynote to the situation really rests with the public and that the incentive to progress lies chiefly through the channel of public demand for and appreciation of meritorious domestic ceramic art now already being produced. There is in this connection some confusion in the point of view as to just what is the issue under discussion. It is not my understanding that we have in mind here a type of art, which shall be known as typically American, as there will always be the requirements for period design. What we really wish to convey to the American public is that in any field of art, whether Foreign Period, American-Colonial, or Modern, the American ceramic artist will be found equal to the demands. The growth or increase in numbers of those American institutions, which can operate in the field of creditable ceramic art and at the same time meet with economic success depends upon the appreciation of the public and their increasing desire to procure a fine piece of American ceramic art rather than a foreign made piece of equal or inferior quality.

An educational campaign through coöperative or individual advertising on the part of domestic manufacturers, is probably the most practical means of creating this proper attitude on the part of the people.

[1] See Editorial "American Ceramics for Americans," *This Bull.*, pp. 1-3.

Such publicity would at the same time stimulate producers of American ceramic art to greater efforts.

The following are the expressions of opinions received.

F. K. PENCE,
CHAIRMAN, COMMITTEE ON PUBLICATIONS

A Successful White Ware Manufacturer

I believe that Sebring's ivory-colored body is equal in every respect to the best earthenware body and glaze in the world. I believe their Barbara-Jane and Gadroon shapes, which have been placed on the market during the last three years, are highly artistic and compare favorably in design with any shapes made by any other earthenware pottery.

The matter of getting attractive decorations is a problem. If we always knew what would appeal to the people of good tastes, the question of supplying them with suitable decorations would be comparatively a simple one. However, a type of pattern that appeals to one will not be considered by another, and we must, if we remain in business, cater to all.

We are striving earnestly to create new distinctive designs, designs that will please the American people of better tastes, and I believe we have made considerable progress. I also believe that our progress from now on will be more rapid than it has been in years gone by.

In comparing American patterns with the patterns coming from foreign countries, you must bear in mind the fact that the foreign potters, as a whole, ship only their choicest patterns to the United States. This is done for the reason that the American people have been educated to buy only the best of foreign patterns. All of the patterns from the American potteries must stand in comparison with these choice patterns from the foreign potteries, and this, of course, does not tend to show American wares to their best advantage.

If you will walk through one of your leading department stores, examining all the foreign patterns on display, you will doubtless find that quite a large percentage of them would not appeal to you at all, and it is only the occasional or exceptional pattern of the foreign manufacturers that is used for comparison with our American designs.

It might be interesting for you to note, that for years, it has been customary for chinaware buyers from the leading stores, to visit annually the potteries of Great Britain and Europe, and some even go to Japan. If these buyers did not buy large quantities of merchandise, it would hardly be profitable for their companies to send them over each year, and when they make the large purchases, it is necessary for their goods to be disposed of when they are placed in stock.

My opinion is that the buyers and dealers and consumers should practice "Americanism" by favoring American products. If the buyers and sales people will earnestly boost and push the sale of American earthenware, it will encourage the manufacturers to produce better things.

A few months ago, a buyer for one of the leading stores notified an American pottery manufacturer that regardless of the kind of decoration or the quality of ware produced, the most he would pay for an American 100-piece dinner set was $20.00. That same buyer pays $25.00 and $30.00 for imported earthenwares.

By a Decorator

There are too few of us who are satisfied to get our "kick out of life" in our work, regardless of a bank account and just live along interested in the beauty of the work we undertake.

I have been trying to get someone interested in making the kind of glass we use in windows for churches. The first question I would be asked is how many carloads could I take annually and when I tell them that about one carload would suffice, they laugh me out with "nothing doing, nothing in it." Could they be made to understand or appreciate the beauty of the material, to take pride in making something equally good as that of foreign manufacturers? No, all they look to is "big business" and they are totally blind to the fact that big business may follow in spite of them if they would first look to quality.

I am afraid that were it not for some enthusiastic individual lovers of ceramic art we should have very little to be proud of. Will Trenton ever become as reputed as Gubbio, Deruta or Cantigalli and many others? We all know the answer: most manufacturers today are much more interested in golf than in their life work. It is amazing how little is spoken of our real interests in company with others. I suppose that would be called "shop" and yet if we are only interested in our work to that extent we are really not vitally concerned.

The Future of American Art from a Ceramist's Point of View

By a Producer of a Distinctive Line of Vases

Our American architects and interior decorators are in a position to use much of our American ceramics but what they do use is little in comparison to the antiques and foreign ware they now handle. This is true for many reasons, the most obvious being that their customers' tastes demand the foreign and the antique. Those who can afford assistance in arranging their home settings have travelled and naturally desire reminders of places visited. Then too, because these customers, our public for the most part, see art only from the viewpoint of periods or localities such as English, French, Spanish, Italian, etc., they are not interested in creative American art. Besides, it is a fact

that larger profits can be made by our merchants from the foreign ware. That these ware come from distant lands adds to the glamor of the sales.

To anyone who has studied the ceramic situation in America at all seriously it is clear that these conditions keep the American art producers from making much headway. For these same reasons the present pottery student, our ideal creative industrial worker, has little incentive to keep to his course. There are not enough employment demands for men thoroughly trained in ceramic technique and art. Even though the love of the subject leads him to the end of his training he is forced into the teaching profession for a livelihood or into something entirely different. Even in teaching pottery there is little incentive, for why educate more students to repeat his experiences. These conditions we all know are the result of the lack of realization of our governing boards of public schools throughout the country of the need of developing in the youth a knowledge of and taste for the artistic in utility as well as decorative equipment for living.

We certainly could not expect the American ceramic manufacturers in the past to lead in the development of American taste for art, for they have had to produce at a profit; they must produce that which will sell in quantities. But until they too sacrifice something to the muse of art and offer larger salaries to technicians who have training in ceramic art production, the day of general popularity of American ware other than for ordinary utility is far distant.

It is to the artist-potter whose great delight is in his power to create something beautiful that we must look for new creations. It is the power of the spirit to soar into the world of the imagination even though his feet go rough shod and his stomach poorly fed that has given America a front ranking in majolica art but rarely on a substantial commercial scale. We are glad that there are well-known exceptional commercial successes in majolica art ware in America and for the well-known but fewer successes in artistic table ware production. We have reasons for pride in the distinguished commercial successes in artistic glass, terra cotta and tile. Progress in production of artistic ceramics in America has been made. We have no reason to hang our heads in shame but we do have reason for finding how to develop an art and a demand for art that will be distinctively American and at the same time we have the task of devising the school training of artistic technicians who can create as well as produce.

In the discovery of Jay Hambidge, one of the most devoted servants of art, there is something which can bind all art workers together. Mr. Hambidge has discovered and has shown us how to apply God's laws of proportion through his books on dynamic symmetry. If we learn to use these principles, artist, manufacturer and student alike, an American cosmopolitan art is inevitable. It was by these same prin-

ciples, previously known and since destroyed that has made Egypt and Greece live, from their temples to their tear bottles. Our very democracy will naturally produce a different art but unless our present and future designs, already showing beauty and charm of color, have also the style and proportions similar to nature's own harmonic spaces we cannot expect to live whether we are over-run by our foreign competitors or not.

"Beauty must come back to the useful arts and the distinction between the fine and the useful arts be forgotten. Beauty will not come at the call of a legislature nor will it repeat in England or America its history in Greece. It will come as always unannounced and spring up between the feet of brave and earnest men." —*Emerson.*

By a Manufacturing Ceramic Sculptor and Decorator

The progressive and constructive attitude of the AMERICAN CERAMIC SOCIETY in soliciting criticism, and comparisons of American and foreign ceramic products will inevitably open the way for the real development of a fundamental potter's craft in America.

The technology of clays is but one side of the potters' and terra cotta workers' knowledge of clay if he is to produce anything worthy of his chosen medium.

In America we have undoubtedly emphasized the scientific at the expense of that creative faculty which considers quality in design of ceramic products and quality in form and color rather than quantity production. Present civilization is in too large a degree focused on perfecting tools for immediate material purposes, wholly void of the spiritual creative quality. A great deal of our ceramic products shows a lack of passion for understanding and cultivating the gift of expression which alone leads to esthetic style, wherein one age communes with the spirit that has inspired all lasting creative work.

Egypt of 5000 years ago and China of five centuries ago were from this standpoint more cultured than we of today, whose style in art is still to be created.

It is not that we of America do not care for nor appreciate beauty; no people are greater lovers of it; we wander over the earth collecting it. Why do we not create it and especially in the medium with which we are so blest and in which the civilization of the world has been best written?

Should it be possible in sections of our country rich in clay products that pottery, so-called, turned on a wheel in rather crude form fired to a soft biscuit, decorated with oil paint could be sold as souvenirs of that section? Should it be possible that parodies of the original and beautiful symbolic forms and designs of our early Indian pottery, be manufactured in wholesale style in the East, and sold to the unsuspecting tourist in the West,—as the work of the American Indian?

A day spent in the galleries of the Heye Foundation in New York, with the Indian collection at the Pennsylvania University or the Smithsonian at Washington, will convince the true clay lover that once America did possess a real, creative, productive clay era, having the same fascination of free expression that we find in the Egyptian, Greek, Assyrian, Chinese and Persian products.

What is the secret of this free expression of beauty that we miss in our ceramic product of today? How shall we repossess it? Have we not in our haste to perfect the "tool" lost sight of or ignored that great law of order that controls all creative work?

Clay products are works of art only when the law of general and durable order, of unity, inspires the mind and hand of the clay worker.

Science which defines the relation of fact with fact; art which suggests the relations of fact with man, and the inner vision that coördinates facts and man, (through some harmonious method which has been man's priceless gift in varying degrees through the ages) must be united for creative work.

"A civilization is a lyric phenomenon," and imposes itself upon us through an impressive living, coherent, and durable style.

We are just waking up to the fact that the ever new road to joy is not to be found in material production that is not made alive and eternal through the spiritual consciousness that pervades the ceramic treasures of the great museums of the world.

Clay, more than any medium, has been the chosen one in which to record the history of man; greatly, when man's vision of the spiritual side of life has been great. The transforming constructive power of art has found free expression in clay and glass.

The beauty of the universe has not altered since the day when man first gave beautiful response to his perception through creative products of utility; the need is well proven for opportunities for the earnest clay worker to study not only the technique of clay and glass but also design, symmetry of form and color and their relation.

Great tracts of our country rich in clays are being developed and ceramic products are being imported in great quantities to supply the building demands. How best can we give our ceramic workers the great principles that inspire all creative work except through opportunity to study the great museum collections, to study the history of ceramic art and the technique of ceramic fabrication.

A Manufacturing Art Potter

It seems to me that it will help the standing of American art pottery if we encourage more craftsmen to find their medium in clay. This may be done by planning a course of study at the schools where ceramics is taught for the benefit of the craftsman as well as one for the engineer,

and also at the schools where art is taught, to include enough of the technique to enable them to be able actually to make pottery that they can expect to sell at a profit.

The emphasis in the ceramic engineering course is on chemistry, physics, machinery, production, and in the art school, theory of design, color harmony, modeling; and neither of them really fill the need of a man who wants to be a potter craftsman. I suppose the answer to that is that there is no demand for such a course; but if you will look about at the few potters in this country you will find that a good many of them have been artists who have taken up clay work with almost no technical training back of them and while many of them are doing excellent work, they still are hampered by a lack of knowledge of formulas, machinery and methods and this lack is often reflected in their prices.

Is there not some way of offering a condensed two-year course that will lay at the disposal of the craftsman all the technical knowledge that he needs with more emphasis on the shop problems, the cost of manufacture etc., as well as a good grounding in design, color, history of ceramic art, contemporary work and trust to his native ability to work out the thing that the decorators seem to want, the "American flavor?"

Just a word about this "flavor"; I feel that what they like in the foreign ware is the absence of the machine; the Italian bowls have been thrown on the wheel; the Quimper plates have been painted with a brush, the big Spanish oil jars have been shaped by hand and they are all intensely human; how is it possible to adopt factory methods and produce in quantity and still hold the human touch?

The decorator does not want a piece that is duplicated in large quantities; he wants to give his client something a little more exclusive, and when he looks for American made work of that type he has very little choice as there are so few craftsmen working in clay. When he does find it, it is probably a great deal more expensive than a similar foreign made piece, partly due to natural economic differences and partly because a good many of the potters think of their work as a fine art instead of a useful art.

I do not think it is so much a question of foreign or native ware; let some potter make in this country serviceable table ware as interesting in form and color and texture too as Quimper, for example, at the same price and the public will buy it just as readily; but is there a factory organization in this country that can fit that work into quantity production or is it a question of having many craftsmen working together? I think the answer to the question of more distinctive American art pottery is to have more trained American potter craftsmen actually working to express their ideals in clay.

And it seems that a shorter, more specialized course offered in connection either with ceramic schools or art schools would help the situation.

America will always be able to meet competition on factory made products; it is another question trying to meet foreign feeling with anything except American feeling.

By an Editor

I recently visited three department stores in Chicago where extensive china displays are made, and spoke with the buyers about the difference between American and foreign ware. In each case they made statements to the effect that American ware, from a technical point of view, is superior to imported, but that the artistic appearance of the foreign ware outweighs that of the American. To illustrate this point, a half-dozen plates were selected at random and placed on a table. These were examined very closely, and it was found that the domestic ware really had the edge on the imported ware when it comes to workmanship. A passerby was asked what pattern she would prefer should a set be offered her, and, strange to relate, in each case one of the imported plates was selected. This indeed seems odd.

I feel sure that we have in our midst, many who can be schooled so as to develop ideas which would, when incorporated into the production of American white ware, place the domestic product in such a position that the American housewife would demand it for her table.

A Porcelain Manufacturer

My company manufactures porcelain insulators for high voltages, and in this field we not only have no foreign competition, but on the contrary a considerable volume of our product is exported to all parts of the world, so that the reverse condition exists as compared to pottery. American high voltage electrical porcelain is not only superior to any foreign product but, I believe, is also made at less cost. This is due to the fact that the electrical industry in America is far in advance of any other and the porcelain insulator manufacturer has had to keep pace. In other words, we have kept our eyes on the user of our product, anticipating his need at times, and have forgotten ancient traditions and customs of the ceramic art. This policy, I believe, has been lacking in the American pottery industry and is largely responsible for present conditions. America has been satisfied to use the methods and customs which were brought over from England years ago.

The development of pottery with an American flavor would seem to me to be one of the outcomes of such a policy. This is, of course, something that will require considerable time but surely the necessary talent is available or can be developed. Art courses in the ceramic schools, as proposed by Mrs. French, will be a great step forward and I think will do much toward developing this talent.

The ideas of the Committee on Education also follow along this line and should be given much thought by the ceramic schools. It should be possible to establish a products course which would permit each student to choose one of the more important ceramic products, make up commercial designs, study the service conditions which it has to meet and the possibilities and limitations from that standpoint. With the talent which is available at our universities, valuable work should result even though it accomplishes nothing more than to stimulate thought relative to our ceramic products along original lines.

An Importer

After viewing some of the products of American manufacturers and comparing them with products of foreign producers, I cannot fail to see that we have overlooked a very serious side of ceramic manufacture, and it seems to the writer, that we have disregarded certain principles of merchandising which would make our ware more acceptable to the public. Perhaps the lack of that intangible something known as art is a characteristic of America. Certainly, other lines of industry have discovered this lack and have overcome this deficiency with very good results both from the aesthetic side as well as the commercial.

I realize that this is no child's problem and that many attempts will be made to produce ware which will be a dismal failure. This will probably be due to a lack of understanding of real aesthetic values among producers who have been thinking in terms of production, cost, and of commerce. Mr. Kipling's comments in his poem, "It's pretty but is it Art" will no doubt have their repetitions in actual attempts of American producers to reach the real wants of the buyers. Nevertheless, this will be a step toward the goal which the writer believes the ceramic producers of this country must, and eventually will, reach.

We think especially well of Mr. Robertson's suggestion that American producers produce a style of ceramic products as typically and really American. He suggests that this is being done by architects of the country. We know that this is being done by the musicians; we have no doubt that it will be done by the ceramists and by the AMERICAN CERAMIC SOCIETY. It will have to be done by artists, and if this movement does nothing else than give the artists a chance to express themselves through actual ceramic manufacture, it will have gone a long way toward the eventual goal. Actual observations in the ceramic industry have led the writer to believe that even those plants which employ well-trained artists often fail to allow them to exercise their ability. Perhaps this is due to manufacturing conditions; perhaps through blindness of certain producers. If we can remove the obstacles which are confronting the ceramic industry today, we shall be making a

big step, and if nothing else is accomplished, we shall have at least tended to alter conditions.

A President of a Successful White Ware Company

I do not believe that there is any doubt but what ceramics of America can be made as artistic and as well as anywhere in the world. And I believe the main or rather basic reason for their not being in that class artistically is one of cost of living or method of living.

The writer took to Chicago last February, five hand decorated sample tea sets, or bridge sets as they are sometimes called. These were decorated by the head of our decorating department, who was for many years in Bavaria, but has been with us twenty years in charge of our decorating.

These bridge sets were different from anything on the market and were quite artistic in decoration as well as shape. Quite a number of the buyers admired them in our display room, in fact most all expressed their admiration. Quite a number wished to place orders but practically all of them backed out when price was mentioned. Invariably they would say, "We can get these short sets $2.00 a set cheaper, made in Japan, Czechoslovakia, and Germany.

As you no doubt realize, our laws will not permit us to employ girls or boys, as the age limit brings them out of that class. Then, too, we can only employ young women at a limited number of hours per day.

The foreign potters making these sets are not so limited. The entire family in a good many instances contribute their part to a decoration of a set at a wage that is about the same per day as we would have to pay per hour.

Let us take for point of discussion, an instance where we would import an artist and his family to decorate for us. In the first place his children would have to go to school, therefore they could not work in the pottery. That would mean that the man would have to make more money to make up for this shortage. He would find that in order to live he would have to have a great increase over what he was getting abroad.

We would not permit him to take our ware to his home and decorate it. This again would mean another increase on his salary. Therefore, he would be getting the same wages that our American artists have to have to live on and keep within the law regarding education of their families.

The ceramic industry greatly needs ceramic art schools or art schools that will study ceramic art. However, those students will not enter on this life's vocation until they see sufficient remuneration when they are

through to warrant them taking it up. Thus that brings us back again to the subject of wages or salary.

It strikes me that this is the controlling element after all has been said and done in ceramic art. To a great extent the artistic merit of a ceramic piece is a matter of personal taste and opinion.

Students from different art schools differ greatly. People differ in their taste of art as they do in most all things.

Our plant started here some twenty-one years ago with artistic ideals, that of making a thin transluscent china body and hand-painted, highly decorated art pieces. It was only a matter of a very few years before we were practically bankrupt.

We found that artistic samples of our vases fully decorated and selling as cheap as we could make the white blank were being imported. On top of this there is the ever-spoken phrase that so many of our retail establishments have built up and practice quite consistently, "It is imported, Madam." It seems to be a magic phrase.

Finally, if we want American ceramics that will lead the world artistically this phrase must be dropped and in its place one such as, "This is made in America" used.

We must be willing to pay a higher price because we live higher.

From a Superintendent of a Large Factory

Mrs. French's article on "Uses of Ceramics in Interior Decorating" has opened up a question of very serious import to the manufacturers of decorative ware in this country. There is, however, a doubt in the writer's mind whether the reason for buying imported ware is largely a question of better quality and more pleasing appearance.

The writer well remembers visiting a pottery in Silesia some eighteen years ago and seeing a vast quantity of plates being manufactured, decorated with gaudy flowers and heavy gilt edges and being told that they were being made exclusively for export to America. On the other hand the line of ware made for the domestic market was much more refined and pleasing to the artistic sense.

This would seem to show that there was at least at that time a strong demand for the crude, gaudy and inartistic product of mass production and that the fault lay with taste of the ultimate buyer rather than the manufacturer who was filling a decided demand.

I believe that more attention is paid in Europe in the education of the people to the development of a sense of the beautiful in art.

In the foreign ceramic schools much time is devoted to the study of art, each student being encouraged to develop his individuality both as to technique and to design. Special stress is also laid on the importance of first adapting the shape or outline to the material and then the decoration to the shape. For instance, the execution of vases with very

slender stems, grotesque handles and sharp corners, suggestive of wrought iron or wooden scroll work is strongly discouraged in favor of the development of flowing curves which are pleasing to the eye and practical in execution.

As for the development of a distinctively American type of pottery the writer feels that, perhaps by using the southwestern Indian pottery as a basis for form and color and conventionalizing the design, a striking and beautiful technique could be developed which would be as distinctive and artistic as some of the famous European products.

A Manufacturing Manager

Being quite familiar with both foreign and domestic production in the ceramic and other lines we feel that the statements of Mrs. French and also of Mr. Robertson are absolutely correct.

As to the AMERICAN CERAMIC SOCIETY trying to correct this matter we do not feel that this can be done within the present scope of the SOCIETY for the simple reason that the situation is a commercial one and cannot be remedied from a technical standpoint.

If ceramic chemists were trained to act as purchasing agents or buyers, they might tackle the situation and induce their superior officers to pay more attention to public requirements and desires, rather than to decry mass production either in design or bodies and glazes. Most members of the AMERICAN CERAMIC SOCIETY are strictly technical men, hence the remedy must lay with those members who are artistically inclined, for they must study American requirements and desire in the same intense manner as our foreign competitors and which at present give these foreigners the advantage over our native intellect.

In the ceramic schools of this country the artistic side is only slightly mentioned and taught. The American ceramic schools do not give their students an idea of the actual problems which will confront them. In a few years' trial in commercial ceramic plants they are stunned to find that they have missed that for which they served an university apprenticeship, so they drift along lines of least resistance. They do not as a class become creative. As a class our ceramic graduates do not have initiative, but we are grateful for the exceptions. We need more graduates of ceramic schools who have exceptional creative ability.

By Manager of Art Ware Pottery

The American artist, the American designer, the American artisan and the American manufacturer seeking to coöperate in producing art objects worthy of being bought by the American public, have always had to face the patronizing and therefore discouraging attitude reflected in the article by Myrtle M. French reporting the criticisms of Lionel Robertson. However good the intention, they show no real sense

of what has already been done in this country and therefore give no recognition by which to stimulate hope for the future. Furthermore, they lay down for guidance theoretical principles that are utterly impracticable from the standpoint of artist, manufacturer, or public.

It is because these theories do not apply abroad that the ceramic industries are efficient in producing quantities of ware salable at prices below any possibility in America. These in the main are not of unusual artistic merit. On the contrary, they are on the level of the usual ordinary, conventional taste, with no sense of original, fresh artistic quality. And what the American store buyer abroad brings back here is usually the worst and not the best of this European ware. To compete with Europe in the making of even more of them in this country is beyond conception. The intelligent American artist, the better he is developed by training, simply will not make them. And the American manufacturer cannot meet European and Japanese costs.

These are what our would-be consumers *do* use, because of price, mainly, and of a certain thin respectability of design or style that may not offend. These things we appropriate from all over the world, fitting them into our surroundings for some quality of their own that we think worth the price. They have an interest in what they reflect, however weakly, of the quaint charm of human life of other countries and other times.

But, not for a moment can we imagine this as leading us anywhere toward the making of new ceramics which we are told "we, as Americans, are going to develop as a racial flavor in the pottery we are making." Racially we are European,—Nordic, if you like, blended with the Latin and a bit of Slav, or whatever the mixing pot of southeastern Europe may be. Racially, we are not American Indian and have no intellectual contact with his inner consciousness or his fundamental quality of design. That is no source of national flavor for us.

One of the troubles of many a so-called interior decorator is that he quite often approaches his problem from the wrong end. Obsessed with a certain quasi-period idea (a far cry from Mr. Robertson's desired "national flavor") and a predilection for some certain color, he subordinates all else to these two factors. The world must be ransacked to supply the desired incidental notes for this scheme. If a red or blue piece of pottery will turn the trick, it matters very little if this piece has no intrinsic merit. The piece of Spanish or Italian pottery is bought, not to gratify and satisfy the collector's love of a rare object of art, but rather that it may react benignly to his doubtful Spanish chair or his "nationally flavored" Italian wall color, whereas in Japan the whole room would be built around and subordinated to the beautiful vase. There should be, of course, some sort of a happy compromise in which

jewel and setting assume their relative positions, but the art of today which is really creative is too full of our own life to subject itself to the shifting needs of the decorator who may reflect only a shadowy Elizabethan, Victorian or, what not, tradition.

Rookwood has worked at the problem for nearly fifty years. Have they failed so completely that all that Mr. Robertson can say is that "the Rookwood are really graceful in form?" Indeed, if this be true then I would say to Mr. Robertson, do by all means make pottery, but do not dream about it too long as the easy occupation of advancing years, for here as elsewhere, "art is long but life is short."

Rookwood has been given the highest possible award in every foreign competition. The French, generally considered good judges of merit, have always been particularly enthusiastic over its artistic qualities.

Granting that there is a great deal of very poor ware made in America, the same is true of every other nation. Naturally, every effort should be made to raise our standards. There is, however, another question involved which is hard to understand.

Why is is that the general American public prefers artistic products made in any other country to those made in America? This is true of paintings, fabrics, jewelry, ceramics. Mr. Robertson may say they are better, but I think quite the contrary could be proved in many instances. One of our agents once told me that if we would only ship our ware to China and have it sent back to him from there he could easily get recognition for it on its merit.

A similar case occurs to me of the amazement expressed by some American surgeons who had gone to Berlin to study when they saw an American perform a very difficult operation far better than the Germans could.

Ought we not as American manufacturers seriously aim to raise our standards, but also aim to get out of the American mind the idea that because it is American it cannot be equal to a foreign product.

A Ceramic Material Importer

Sometime ago I took the liberty of writing a letter to the Brotherhood of Operative Potters, and in this letter I briefly stated that it was entirely up to the pottery employees to produce an article that would be A-1 in every respect.

In my travels throughout England, the United States and Canada, it has been my pleasure to see the production of virtually every kind of ceramic ware, and I still am of the same opinion, namely, that the manufacturing potter of America, in conjunction with his employees can, if they so desire, manufacture ware equal to any other in the world. This is not an idle boast, and I think can be proven very conclusively by the following facts:

America today is the builder of the finest automobiles in the world; then, we have the Eastman Kodak Company who are manufacturers of an article that is worth while. Our moving picture industry is preëminent throughout the world, as well as our shoe manufacturers. England has adopted American shoe machinery, and today they are manufacturing shoes there equal to American made, and not the old clumsy boot. Then again, there are our magnificent buildings which prove that we have wonderful engineers and architects. I could go on indefinitely as to the many things wherein America is supreme, which would only prove my contention that the American potters can produce, if they so desire, an article par excellent.

First of all let us consider the manufacture of dinner ware. We are referring to Mr. Shegog's recent statement in East Liverpool. One of our great troubles is that we do not stop to consider the artistic. We seem to think of business in mere terms of production. This is entirely wrong. I could cite to you various dinnerware manufacturers whose one aim seems to be the manufacture of an article worth while, and in going over their costs of production they are not paying any more for the good article than some other pottery manufacturer is paying for a far inferior article. The time is here when the American potter must be original and produce an article that will meet with any and all foreign competition in originality, artistic design and style, who will place his article before the American housewife in the proper manner.

We shall now turn to the manufacture of American china, eliminating the Lenox Company of Trenton, who are making a most beautiful article. I would particularly refer to the Scammell China Company of Trenton, N.J., formerly the Maddock Pottery Company, who are original, insofar as designs are concerned, both in the decoration and the lines of their goods. It is a pleasure to look over some of the ware made by the Scammell China Company just to see the originality of same. I feel quite confident in saying that the Scammell hotel ware will compare favorably with any ware made in any part of the world, and the most pleasing part of this is that they are original, and not copyists. I might pass on to the Onondaga China Company of Syracuse, N.Y., who are also making a very excellent grade of china, both dinner ware and hotel ware. The Shenango Pottery is making a very desirable hotel ware line, and several others also.

The American sanitary manufacturers stand out absolutely supreme as making an article that cannot be excelled by any foreign made goods. They are making an article that will meet with any sanitary code. This applies to all the sanitary articles made in the United States.

Now let us pass on to such ware as made in and about Zanesville; Roseville, and down at Cincinnati by the Rookwood Company. Many of these companies are making some very artistic articles.

The tile manufacturers of America are doing very creditable work.

After giving this subject very careful consideration, I feel that one of the greatest troubles with the American pottery industry is that the foreign manufacturer of ceramic ware is the one who does a great deal of propaganda work. Look through the American journals and you will see standing out very prominently Haviland china, Roslyn china, Limoges china, Crown Darby and Sèvres china, and numerous others. If the American housewife would only stop to consider what every purchase of foreign made product means to the American manufacturer, I really feel she would think twice before making the purchase. If our American housewives continue to buy foreign made goods, as they are at the moment, it simply means that the American ceramic manufacturer will close shop, many men will be out of employment, and the American housewife will not have the means to purchase foreign made goods. What I would like to see is the American ceramic manufacturers join together, advertising very prominently American made goods, and what it means when the American housewife purchases American made goods, and not the foreign made goods. We must keep American industries running.

Our American manufacturer should see to it that he produces an article that will appeal to the American housewife. They must advise their employees that they make an article that will sell at a decent figure. The American potter should discontinue the scheme goods game, and manufacture an article that will sell on its own merits.

CERAMIC ART AND THE CERAMIC ARTIST[1]

By Edmund deF. Curtis

The American Ceramic Society came into existence because it was necessary to have a more solid scientific foundation on which to erect the great industry visioned by the men who sponsored it than was possible under the "rule of thumb" methods in vogue at that time. The activities were, at that time, necessarily all directed to the scientific aspect of ceramics and I think I may state that they still are. Now, however, that this scientific foundation is firmly established, there is a feeling that perhaps after all it is lop-sided.

The gulf between art and industry in ceramics is great; and I think it is due very largely to the fact that there is not any provision made in undergraduate work for the training of real ceramic artists.

If you interpret the theme of this Meeting, the question of giving more time to the product, as meaning that the engineer will now and

[1] Presented at American Ceramic Society, Fall Meeting, New York City, October 1, 1925.

then jar himself loose from the fascination of colloidal chemistry to listen to a few lectures by specialists, who perhaps could go from one ceramic school to another, on such subjects as "Pottery and Tile as Used in Modern Decorative Schemes" or "Terra Cotta Problems from the Architect's Viewpoint," it would help a lot.

If you interpret it as meaning that the ceramic art student would be given practical problems such as the design for a big oil jar for a landscape architect, and be made to learn the process by which it is manufactured and how much it ought to cost, it would help. These men later would have a far better understanding of each other.

But I think that in order to raise the standard of American ceramic art to the heights we may justly expect, judging from the progress made in the science, from the artistic talent developed by other industries and from the present state of our culture, it is necessary to bring into being the ceramic artist—and we must not under-estimate the caliber of such a man.

He must have his art training, color, design, history of art, appreciation of beauty, development of taste, and he must also definitely be a practical potter. It is not possible to go to any artist and say: "Make me a design for an overmantel panel" and take it to your shop and execute it. I do not mean it could not be done, but it would not be the best that could be done; and probably it would not be possible to do it within the price limits and make it pay. And this question of "making it pay" is almost an integral part of the work. Ceramic art does not lend itself to "art for art's sake." The artist's tools are expensive to operate and to attain perfection he must be using them. The ceramic artist must visualize his design, executed in ceramic colors, with ceramic textures, by ceramic processes which are possible in the plant in which he is working, and at a price which is definite. And to have that knowledge he must know his materials, his processes, his machinery and his costs, and I think only a practical potter, (a craftsman potter) can do that. This is not the time to offer any suggestions as to how to plan his undergraduate work except to say that it is not impossible to give him sufficient practical work in a year and that this could be done at the expense of the more scientific work that he does not require.

The great responsibility, however, is this: Having encouraged him to study such a course, how are we going to see to it that he does not starve to death before the industry as a whole begins to take care of him, and that difficulty, I think, would be automatically solved by the fact that he will be a craftsman. It will only be necessary to unfold the many possibilities of fired clay as a medium for artistic expression to him and to urge the machinery manufacturers to cater to his needs—and

who shall say that from him we shall not have another Lenox or Wedgwood?

If this change can be made in the undergraduate work we should not see the conditions we see today: Men and women, with artistic ability and some technical training, with no place to work, to develop, to grow, not fitting into the present industrial scheme and with no conception as to how to start out for themselves. Practical craftsmen looking at the machine as though it were so much poison, rediscovering, each for himself, processes, methods and formulas that ought to be common knowledge. Artists drawn to pottery as a medium of expression without any technical or practical training, putting good design on poor quality pots, running with a heavy percentage of loss, pricing their ware at a high figure chiefly because their costs are so unnecessarily high. Going concerns, founded by artists without technical training, making desperate mistakes, cheap American ware, with no artistic merit, and good American craftsmen's work at three times the price of foreign ware, but no combination of the efficient shop and the art spirit. Important retail stores are without a piece o American ware because the public misreads the "imported" label: they think it means "direct from heaven."

I feel very strongly that most of the work now being done by a few American craftsmen is of better quality than the imported ware of the same type, and I also feel that it could be made in sufficient quantities and at a price that would enable us to compete with foreign ware, provided we had the absolute coöperation of artist and factory, and that while the volume of that business may not be great enough to interest the large plants, it still would give a wide opportunity for many practical potters.

Now, I suppose I have stepped on some one in my own section. I can hear a rumble that says: "But that is not art—when you turn them out by the dozen." I have three answers which seem good to me: one, that the artists would still be working, but they would be working on a higher plane, making the things that cannot be put through in quantity, the signed original and the textures and colors that only develop with the master hand at the kiln. The second answer is that if they will look up the letters of the Jesuit priest, Père d'Entrecolle, who sent back to Europe from China the first detailed accounts of their processes, they will find a decided flavor of Henry Ford. The piece of ware going rapidly through the hands of 70 men, one man who only painted eyebrows, for instance, and they will realize that it is not the secret glaze, nor the process; it is what you do with it that counts.

The third answer is that if such a change will enable many to find contentment and earn their living doing the work they love to do, that in itself is an art worthy of the name.

So I urge that in considering any change in the undergraduate work that you, by all means, make adequate provision for the trained ceramic artist, a man who knows what to create, how to design it so that it measures up with the best of ceramic art, how to design it so that it may be translated into industry, a man who can grasp the fact that the pencil, the modeling tool, the kiln, the jigger, the skilled worker, the unskilled laborer, the pug-mill and his own cultural background are all tools that he must know and understand and use. Create such a man and it can be done—and in ten years the standard of American ceramic art will be where it ought to be.

All too visionary? A dream? Perhaps it is, but the practical potter, the craftsman potter, is the kind of man who rolls up his sleeves and sweats to make those dreams come true.

Conestoga Pottery Co.,
Wayne, Pa.

AMERICAN CERAMIC ART FOR AMERICA

By Martha T. Weaver

The United States of America has built up a commerce strong enough to support an art of its own. No nation was ever great without art, and the greatest nations have an art peculiar to and expressive of their own life, growing with the life of the people. In America the schools of art and especially the museums of art, established by far-sighted men, are large factors in developing this art life of the people.

The Cleveland Museum of Art is reaching practically all of the public school children of Cleveland by sending out lecturers and cases of its art materials from the Museum into all the public schools in the city. It also invites children to the classrooms and galleries of the Museum, and provides special teachers for these children. Six years of this sort of work has made a marked change in the homes and in the children. Ten years more and these people will be keeping industry busy with their demand for the more artistic goods. This demand surely will be made of ceramic producers.

To create a distinctive American ceramic art we must train persons to (1) understand the public demands, (2) know pottery making in all its phases, and (3) be practically trained in the principles of art. This is not a far-fetched nor impracticable suggestion. It could readily be worked out in several ceramic centers. In Cleveland, for instance, the college could give English, science and mathematics, the Cleveland School of Art could give the art training and the ceramic vocational training. The inception of such a program, however, rests with owners of plants in which wares requiring art are made.

Whether such art training courses will be provided depends upon whether: (1) the ceramic industry can use art and ceramic vocational art workers; (2) what standard should be attained through art study and ceramic vocational work to meet the shop requirements; (3) what courses of study would give the required training; and (4) for how many avenues of employment could a ceramic art student and vocational worker be trained?

Is there a ceramic industrial society or individual plant willing to offer a scholarship amounting to two hundred dollars? This has the the effect of producing earnest work from the beginning for best results. It would in no way impinge an obligation upon the donor to the particular student who would win it.

A suggestive course to prepare artist-potters for work upon ceramic art problems is presented.

Students from high schools, who have had physics and chemistry, may sign for the work.

First year[1]: Cleveland School of Art Freshman course and English—physics—accounting at the college.

Second year[2]: Cleveland School of Art Sophomore course and English—chemistry—higher accounting at the college.
Ceramics one full day each week.

Third Year: Lectures—properties of clay—clay mixture—clay preparation and use.
Lectures—glazes—principles, production, use.
Lectures—kilns—firing.
Study—English—drawing—design.
Practical work—model and mold making, casting, jiggering, turning, kiln-stacking, firing, drawing.

Fourth year: Study—English—drawing—design of form and decoration.
Laboratory practice—glazes—preparation, use.
Application—of design for tableware—glass, vases, etc.
Decoration—embossing—painting—decalcomania—lining—gilding.

---

[1] First year: Drawing from natural forms, common objects, casts and other recognized standards. Elements of anatomy, elementary figure drawing, modeling in relief and the round. Lettering, mechanical drawing, and the theory of perspective. Pocket sketch books, water color rendering from still life, birds, plants, etc. Decorative design, anatomy of pattern, theory of color, block printing, gesso and other processes. History of the arts, with notebooks.

[2] Second year: While many of the subjects remain the same the work is more advanced, the problems more difficult of solution, and the required standard of technique much higher. The figure drawing includes work from life with anatomical analysis and modeling the figure in the round. Lettering, perspective and the theory of color now become elementary commercial design and pictorial illustration. The still life work is now done in water color, tempera and oil. The elementary decorative design leads to designing for textiles, wall papers, book covers, etc. History of the arts continues, with note books. Sketch books required.

Graduation would require a written thesis on the making of a piece of ware that has been independently carried through successfully—clearly stating each process, defining materials used, with notes on special incidents.

A Working Plan

The course of study suggested would be for the purpose of cultivating the so-called "artist-potter" for industry. This will help in America's problem of developing an Art of her own.

Necessity for copying is now past as America has the colleges, the schools of art and the vocational training schools. It remains for the industrialists to coöperate with these schools. If ceramic industry were to equip a school for all that the colleges and schools are now prepared to teach in the sciences and art they would have to have a very large outlay in buildings, equipment and instructors, and at best they could not have the breadth of vision and training that is available in schools of art, where all art problems are considered. Our artist-potter cannot afford to be narrow, nor yet of a mushroom growth.

The Cleveland School of Art is here cited merely as an example. The same statements would hold for any college where a school of art and the ceramic industrialists will unite their interests. The workable scheme would be for the Cleveland School of Art to supply the rooms, part of the equipment, the running expenses, and income of the professional art instructor; ceramic industry to supply part of the equipment, the mechanic to set it in running order, the income of the ceramic man to run the jigger, the mold-making and casting rooms, and the kiln for at least four experimental years. If a scholarship of $200.00 a year were offered from the ceramic industry it would have a wonderful effect upon the student for good will and earnest work. At the Cleveland School of Art the architectural artist-potter can also be produced as the architectural school is next door, and already sends its students into the Cleveland School of Art for perspective, mechanical drawing, history of the arts, etc.

The function of the ceramic division of a school of art is to produce the professional art man and the artist-potter. The artist-potter graduate of a ceramic division of a school of art must have a stated session of summer work in an engineering school or of practical work in a factory or both.

CLEVELAND SCHOOL OF ART,
CLEVELAND, OHIO.

DISCUSSION ON "AN ELECTRIC FURNACE FOR SOFTENING POINT DETERMINATIONS"

BY G. ROSS

I have studied with great interest the above-mentioned paper describing fully a new electric furnace in the Bureau of Standards by W. L.

Pendergast. Now that more scientific tests on the refractory materials is necessary to the plants themselves in order to keep up in quality of the products a good, simple and cheap testing furnace for refractories is of high importance.

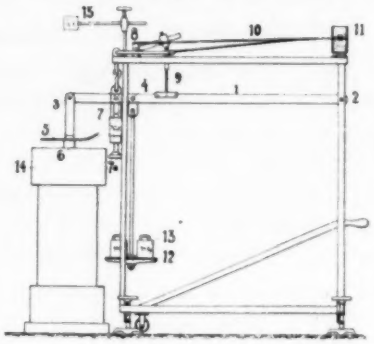


FIG. 1.

The furnace worked out by W. L. Pendergast is excellent, complete in detail and will find a place in the "Scientific Research Institute."

Nevertheless, I feel that the electric test furnace of Dr. Endell and Dr. Steger (Berlin) suits more the practical service in industrial plants. This furnace is more simple than Pendergast's furnace. It has connected with it a very simple apparatus for measuring the softening point under load. For engineers in industrial factories, the softening point under load is the most important item to determine and corresponds to actual conditions in use. More than 70 of these test furnaces have been installed in the world.

SALTILLO, COAH (MEXICO).

ACTIVITIES OF THE SOCIETY

A NEW YEAR'S GREETING

Assurances of personal participation in this coöperative enterprise which we have termed the AMERICAN CERAMIC SOCIETY is certainly the best sort of greeting that we members can extend to one another. To me, as General Secretary, these assurances are particularly pleasing for I love to labor for those who appreciate the efforts which the members individually and collectively are making to push as far forward as they can the art, science and technology of their chosen vocation.

The credit for the advances made in 1925 does not belong alone to the SOCIETY. The ceramic press, the schools, the trade associations and the research laboratories have been pushing in the same direction. It is very satisfying that the harmony and close paralleling in these efforts make it impossible to estimate what proportion of credit belongs to each of these several agencies.

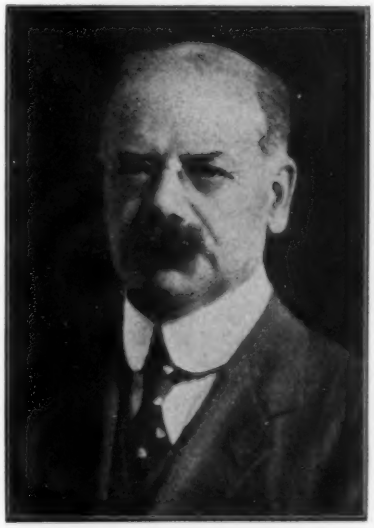
It is sufficiently satisfying to each member of the SOCIETY that as one these agencies contributing to the advances made in ceramic art, science and technology, this SOCIETY has been positive and appreciated.

ROSS C. PURDY

FRANK WEST, PRESIDENT, ENGLISH CERAMIC SOCIETY

Mr. West Will Be with Us at Our Annual Meeting in Atlanta

Connected from his youth upward with that most scientific of operations, the manufacture of coal gas, Frank West commenced his training by an apprenticeship with the West's Gas Improvement Co., Ltd., and General Engineers. Following this period of training he served articles as gas engineer with W. R. Chester, then gas engineer to the Nottingham Corporation. He remained in this position until he became chief chemist of this Company.



FRANK WEST

In the year 1897, Mr. West returned to West's and for some years was engaged in superintending the erection of large gas plants in England and abroad, acting, later, as the Chief London representative of his Company.

For many years he has been connected with the Derbyshire Silica Fire Brick Co., Ltd., and has been director of this Company since its inception. He took active control as managing director some years ago and on the death of his father, John West, in 1922, he was appointed to the chairmanship of the Company.

His experience as an actual user of refractories during the early part of his career has obviously been of great service to him in his work as a manufacturer, and none can speak with better authority than he on the whole subject of gashouse refractories, which has been his constant study.

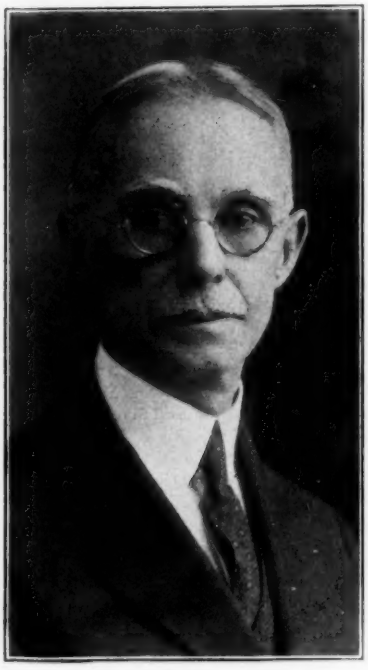
CHARLES H. HERTY

Native Son of Georgia Will Welcome the American Ceramic Society

Dr. Herty is proud of his Georgia birth. He wants the ceramists to be in Atlanta next February for he believes in Georgia. But the Georgians are as proud of their Charley Herty as he is of them, so proud in fact that they secured him to put into words the welcome which every Georgian has in his heart for us. This is a rare compliment to the members of this SOCIETY for there is no scientist who has accomplished more and merits more and has won the admiration and affection of a wider range of people than Dr. Herty.

Charles Herty was born at Milledgeville, Georgia, educated in the schools of his home city and was graduated from the University of Georgia in 1886. He obtained his doctor's degree from Johns Hopkins in 1890 and studied at German universities. He became a member of the faculty at the University of Georgia in 1891, and remained there for eleven years. As adjunct professor of chemistry, he came in contact with thousands of students who held him in high esteem, not only as a teacher but as a man. Himself a football and baseball player, he always took an active interest in all branches of athletics. When the University of Georgia erected a modern athletic plant, it was given the name it bears today, "Herty Field."

In the early days he was in the pottery business making those clay cups in which turpentine is collected. He took over this pottery to show and he did show that they could be made at a non-prohibitive cost.



CHARLES H. HERTY

Affiliating himself with the Bureau of Forestry of the United States Department of Agriculture, he did work of great value to the naval stores industry, particularly in devising improved methods of collecting and handling turpentine. He again donned academic robes in 1905 and was Professor of Chemistry in the University of North Carolina until 1916. From that date until 1921 he was Editor of the *Journal of Industrial Engineering Chemistry*, the official organ of the American Chemical Society, and in that capacity was spokesman for the fifteen thousand chemists of the country.

In the summer of 1919, when arrangements were being made for the distribution of reparations dyes from Germany, Dr. Herty was sent abroad as the personal representative of President Wilson, to secure for American consumers those dyes not made in this country. Dr. Herty found that not all of the dyes needed by American consumers were available from reparations stocks and thereupon concluded an agreement direct with the German Cartel for the delivery of blocks of these dyes under the so-called "Herty Option." Delivery of these dyes was delayed by unforeseen factors, including flood con-

ditions on the Rhine and strikes at the docks at Rotterdam, but during the years 1920-21 large supplies were made available from this source at reasonable prices through the Textile Alliance, Inc. To him more than to any other man is due the happy position in which America finds herself today, in the production of dye stuffs and second as a consumer of dye stuffs.

Dr. Herty's untiring effort and steadfast interest have constantly played an important part in the establishment of an organic chemical industry in this country since the acute shortage of dyes soon after the outbreak of the war first brought this matter vividly to the fore. As president of the American Chemical Society in 1915 and 1916, Dr. Herty with characteristic vision urged the necessity of American economic independence in all branches of chemistry. He earnestly advocated the levying of adequate import duties as a stimulus to the investment of capital, and was one of the staunchest supporters of the Hill Bill before the Democratic Congress in 1916. He is at present a director of the American Chemical Society and President of the Chemical Warfare Association, as well as a member and leading spirit in numerous other technical organizations.

THE AMERICAN CERAMIC SOCIETY DOWN IN DIXIE

(February 8-13)

Seven Meetings in One—An Exhibit of Ceramic Science, Technology and Art and a Royal Welcome and Entertainment

By A. V. Henry

Again the call has gone forth for the membership of the American Ceramic Society to meet, and this year the state of Georgia and the South as a whole will act as hosts.

What is going to be doing down in Georgia? Well, enough has leaked out to give us an idea. Back in the days of 1918 many of us were accustomed to say that all roads lead to Paris. Toward the end of the first week of next February, all roads will lead to Atlanta. Hotel Biltmore has been selected as headquarters and the selection was well made since it assures us comfort and service.

Ladies Invited Needless to say, all the visiting ladies will be with us on all occasions that they desire. During the week special entertainment will be provided for them so that there will not be an uninteresting moment for them. The ladies *must* come.

Exhibits This year a special effort is given to exhibits. Excellent arrangements have been provided for these and the reservations of space already made indicate that a large number of ceramic industries will be represented. We have long since learned to believe what we see, therefore varied, well-placed and decorated displays may be expected.

Dr. M. L. Brittain. President, Georgia School of Technology, Atlanta. Chairman Executive Committee.

Monday Registration, renewal of acquaintance, looking over the city and general sessions will take up the first day, Monday, February 8.

P. T. ANDERSON. PRESIDENT, MACON CHAMBER OF COMMERCE. MEMBER, EXECUTIVE COMMITTEE.

Tuesday The Divisions will each hold their sessions for reading and discussing papers in the forenoon and afternoon. Tuesday evening, after the sessions, we shall be in the hands of the Atlanta Women's Club. The club prides itself on doing things and has arranged a great evening complimentary to our membership. This will end in a supper-dance, given in Southern style. Many of the popular girls of Atlanta will be there, so let's loosen up, practice up and be ready..

Wednesday The Divisions will hold separate sessions as on Tuesday. Wednesday night, the Annual banquet will be held at the Biltmore. We expect this to be the best yet. The state's most prominent men have agreed to give short talks of the typical after-dinner variety. As might be expected we shall again take to the floor to end the night.

J. M. MALLORY. GENERAL INDUSTRIAL AGENT, CENTRAL OF GEORGIA RY. CO. MEMBER, INDUSTRIAL COMMITTEE.

Thursday In the forenoon we are to have a joint session devoted exclusively to reading papers on ceramic science. At noon, the business sessions will close.

After a buffet lunch at the hotel Thursday, the SOCIETY will go by auto to Stone Mountain as the guests of the Convention Bureau and Secretaries Club of Atlanta. All of us have heard of this, the greatest single granite rock in the world, that is being used as a back-ground for the mammoth Confederate Memorial. The sculptor, Augustus Lukeman, will be on hand to explain the details of the Memorial to the membership. The trip to Georgia would be well worth while if for no other purpose than to see Stone Mountain.

DR. R. E. EVANS. VICE-PRESIDENT GEORGIA WHITE CO., GORDON, GA. MEMBER, EXECUTIVE COMMITTEE.

Embark for Macon At 3 o'clock on the afternoon of the same day, a special train, designated as the "Ceramic Special," will take the party to Macon. Macon is one of the pretty cities of the South and is still able to boast of many of the Colonial homes of the old days. It is in the heart of the sedimentary kaolin belt of the State and is quite active in ceramic industries.

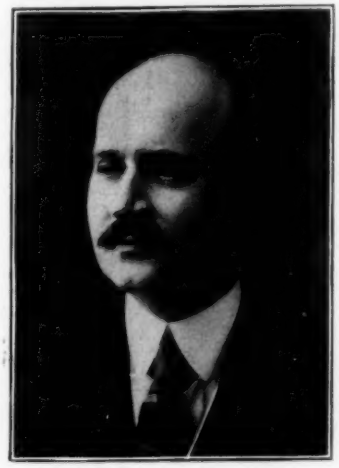
Thursday evening, the members of the SOCIETY will be guests of the Macon Chamber of Commerce at a dinner-dance.

Friday After a few hours of sleep, we shall again board the "Ceramic Special" for Wilkinson County, arriving in McIntyre at 9:15 A.M. Friday. Here we shall visit the clay washing plant and mines of the Akron Pigment Company, which represents a new departure in clay refining. Nearby is the washing plant of Edgar Bros. Company, the largest of the operations of Georgia. A trip through this will be a revelation to the members of the SOCIETY. Immediately after the inspection, the party will be taken via the Company's tram road to their kaolin pit, commonly called the "Klondyke Mine."

DR. A. V. HENRY. DIRECTOR CERAMICS DEPARTMENT, GEORGIA SCHOOL OF TECHNOLOGY. CHAIRMAN, EXHIBIT COMMITTEE AND ASSISTANT TO DR. BRITTAIN.

About noon the party will leave McIntyre on the "Ceramic Special" and proceed to Wriley where a stop will be made to permit an inspection of the Bauxite Drying Plant of the Republic Mining Co. Then we shall continue on to Gordon and there, in a pine grove, an old-fashioned barbecue will await us. If one has never partaken of a Georgia barbecue, one has never truly lived and the clay enthusiasts of Gordon and vicinity, which is to say the whole of Wilkinson County, are determined that no one will miss anything.

The remainder of the afternoon will be largely devoted to an inspection of the Georgia White Brick Company which at the present time is the last word in brick works. This Company is using a combination of raw materials evolved by our friend R. T. Stull in the manufacture of porcelain face brick. While much has been written of the Georgia White Brick Company, it cannot be appreciated unless seen. Gordon is also the home of the Gordon Kaolin Company and Savannah Kaolin Company. We will be more than welcomed here by F. H. Opper, president of these Companies, both of which will be open to our membership. Many, too, will want to go through the Pynetree Paper Company. Here heavy paper and pulp are produced on a large scale from second growth pine.

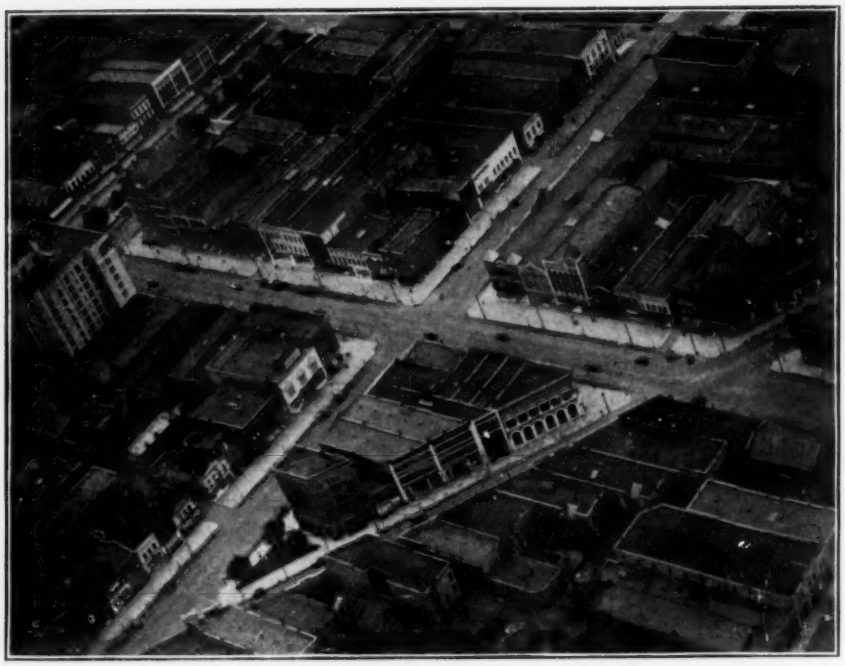


B. MIFFLIN HOOD. MIFFLIN HOOD BRICK CO., ATLANTA, GA.

For those interested in refractories, side trips from Gordon will be arranged permitting an inspection of the plant of Stevens, Inc. at Stevens Pottery. Those members who make this excursion will leave the special at Gordon as it passes through enroute to McIntyre. Automobiles will be waiting to take the party to Stevens, Inc. and later will return them to Gordon for the barbecue.

Friday evening will again find us in Macon and again we shall be guests of the city, this time at a theatre party.

Saturday On Saturday morning, trips have been arranged through the representative clay working industries of the city and vicinity. These will include



THE BUSINESS DISTRICT OF MACON, GA.

COLUMBIA MINE, GORDON KAOLIN COMPANY, GORDON, GA.

AIRPLANE VIEW OF ATLANTA'S BUSINESS DISTRICT

AIRPLANE VIEW. GEORGE KAOLIN CO., DRY BRANCH, GA.

the Georgia Kaolin Company and American Clay Company, both of Dry Branch, the Cherokee Brick Company and the Dickey Clay Manufacturing Company. The Dry Branch kaolins are so well known that all will want to see how they are mined and

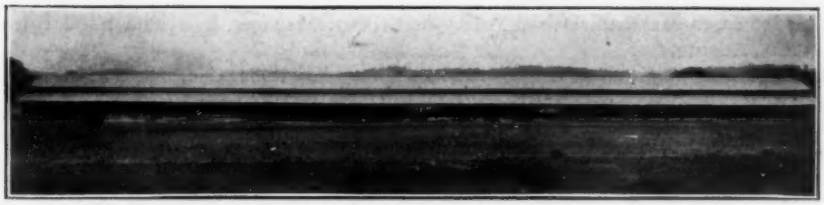
THE ATLANTA-BILTMORE HOTEL, ATLANTA'S $6,000,000 HOTEL, WHERE THE ANNUAL MEETING OF THE AMERICAN CERAMIC SOCIETY WILL BE HELD, FEB. 8-13, 1926.

washed. The Cherokee Brick Company is one of the largest and most modern of its kind in the South, and makes use of a number of innovations that will prove highly instructive. The Dickey Clay Manufacturing Company is an old established producer of sewer pipe and constitutes one of the progressive industries of the city.

CHEROKEE BRICK PLANT, WHICH, WITH THE BIBB BRICK PLANT, FORMS THE STANDARD BRICK AND TILE COMPANY.

After the morning's tour of inspection, the party will be taken on an auto trip through Macon. Since Macon represents both the old and the new South, all can look forward

with pleasure to this trip. As a suitable ending, we shall all gather at the Idle Hour Country Club for luncheon. Once more the Chamber of Commerce of Macon will be our hosts.



GEORGIA WHITE BRICK COMPANY, GORDON, GA.

Here the organized entertainment ends. However, there is so much to see, not only in Georgia but in Florida and other nearby states, that, it is hoped, every member will extend his time to include some of the other sections. If this is done, good-will and hospitality will be met everywhere throughout the Greater South.

STONE MOUNTAIN, NEAR ATLANTA

NEW MEMBERS RECEIVED FROM NOVEMBER 15 TO DECEMBER 15

PERSONAL

Charles H. Burchenal,[1] Cambridge Tile Mfg. Co., Covington, Ky.
F. S. Davidson, 1301 N. Charles St., Baltimore, Md. (Enameler, National Enameling and Stamping Co.)
Lawrence V. Dippell, 4702 Penn St., Frankford, Philadelphia, Pa. (Ceramic Engineer, Abrasive Co., Philadelphia, Pa.)
Louis M. Fuller, Westfield, Mass. (President, American Abrasive Co.)
La Verne N. Gill, Ceramic Student, Iowa State College, Ames, Iowa.
Kozo Kawai,[2] Kyushu Fire Brick Co., Inbe, Wakegun, Okayamaken, Japan.
Henry Peter Kimbell, Student, Univ. of Toronto, Toronto, Can.

---

[1] Mr. Burchenal assumes the membership formerly held by Wm. S. Berger, president of the Cambridge Tile Mfg. Co.

[2] Mr. Kawai resigned in 1925 and joined the Society as a new member in December, 1925.

J. J. Kitaygorodsky, Technical Director of Prodosilicat, Miasnitzkaia 8, Moscow, Russia.
Paul E. Kiwgillo, Director, Syndicate Prodosilicat, Miasnitzkaia 8, Moscow, Russia.
Chester Edward Lampe, 146 Dunham Place, Woodbridge, N.J. Asst. Ceramic Chemist, Federal Terra Cotta Company.
Marsden Laws Marshall, Daisy, Tenn. Asst. Plant Manager, B. Mifflin Hood Brick Co., Atlanta, Ga.
Samuel Matthews, Student, Univ. of Saskatchewan, Saskatoon, Can.
Lev. A. Mekier, 1086 Broad St., Newark, N.J. Consulting Engineer.
C. A. Miketta, Celite Co., Van Nuys Bldg., Los Angeles, Calif.
Howard H. Oberly, 2405 Harrison St., Wilmington, Del. Vice President and Treasurer, Oberly Brick Co.
Peter S. Philosophoff, Professor of Ceramics, Technical High School of Moscow, 16 Wolhonka, Moscow, Russia.
J. Donald Pearson, Student, Iowa State College, Ames, Iowa.
Karl E. Peiler, Chief Engineer, Hartford-Empire China Co., Hartford, Conn.
Myron E. Reynolds, 2044 S. American, Stockton, Calif., Ceramic engineer, Stockton Fire Brick Co.
Ray A. Snyder, Student, Ohio State Univ., Columbus, Ohio.
George H. Spencer-Strong, Student, Ohio State Univ., Columbus, Ohio.
A. M. Strusholm, 256 Bordentown Ave., South Amboy, N.J. Ceramist, South Amboy Terra Cotta Co.
Trymbak Waman Talwalkar, Student, Univ. of Ill., Urbana, Ill.
Edward D. Turnbull, Chemical Engineer, U.S. Gypsum Co., New Brighton, Staten Island, N.Y.
Bertram Lu Watkin, 218 Boyles Ave., New Castle, Pa. Foreman, modeling and molding department, Universal Sanitary Mfg. Co.
Paul G. Willetts, Refractory Engineer, Hartford-Empire Co., Hartford, Conn.
W. C. Woodall, Industrial Index, Columbus, Ga.

CORPORATIONS

The Commercial Shearing and Stamping Co., 1775 Logan Ave., Youngstown, Ohio. H. M. Schaad, General Mgr. of Sales.
Standard Brick and Tile Co., Macon, Ga. W. E. Dunwody, President.

MEMBERSHIP WORKERS' RECORD

	Personal	Corporation		Personal	Corporation
F. E. Allen	1		E. B. Streater	1	
R. A. Horning	1		Floyd M. Thorman	1	
O. E. Mathiasen	2		W. H. Vaughn	1	
R. J. Montgomery	1	1	Hewitt Wilson	1	
A. Silverman	3		W. G. Worcester	1	
Frederick Stanger	1		Office	12	1
				26	2
				Total	28

PERSONAL NOTES

P. P. Budnikoff, formerly of Ivanovo-Voznessensk, near Moscow, Russia, has been selected as professor of technology of silicates at Kharkoff Technological Institute, Laboratory of Mineral Technology, Russia.

R. D. Ferguson has moved from Milwaukee, Wis., to Denver, Colo.

A. F. Gorton has left the Western Electric Company, Hawthorne Station, Chicago, and is situated with the Buckeye Clay Pot Co., Toledo, Ohio.

C. H. Kerr has moved from Merchantville, N.J., to Summer St., Southbridge, Mass.

F. A. Kirkpatrick, formerly of Unionville, Mich., writes to us from Pittsburg, Kans.

Raymond B. Ladoo is located at the Allerton House, 143 E. 39th St. New York City. He has recently been situated at Cowdrey, Colo., with the Colorado Fluorspar Corp.

J. Burnett Matson of West Chester, Pa., has moved to Lakeland, Fla.

Robert Roadhouse is now associated with the Strong Mfg. Company, Sebring, Ohio.

Merrill C. Sondles has moved to Niles, Ohio, where he is now associated with the Atlas China Company. Mr. Sondles formerly was statistical engineer for the Pope-Gosser China Company.

Floyd M. Thorman has been transferred from the Chicago office of the U. S. Gypsum Co., to New Brighton, Staten Island, N.Y.

Thomas C. Walker, Jr., has transferred his activities from the Los Angeles plant of the Los Angeles Pressed Brick Co., to the Alberhill plant of that Company.

R. T. Watkins, formerly assistant in the Ceramics Department, at the University of Illinois is now located with the Department of Mines, Ottawa, Canada.

LOCAL SECTION ACTIVITIES

Baltimore-Washington Section Meeting[1]

The second meeting of the Baltimore-Washington Section of the AMERICAN CERAMIC SOCIETY was held on Saturday December 5, in Washington, D.C. The meeting was divided into two parts, the first being a visit in the afternoon to the Bureau of Standards. On account of bad weather conditions, very few attended this part of the meeting.

At 6:30 P.M. a dinner was served to nineteen members and four guests at the Lee House. Following the dinner, F. C. Brown, Assistant Director of the Bureau of Standards gave a talk on the work of the Bureau, laying emphasis on "standardization," explaining how it had been a help in making products of better quality and at the same time saving money for the users. At the close of the talk by Dr. Brown, Dr. Washburn of the National Research Council was called upon to give an insight into the work of this Council. He briefly outlined the work that had been done on compiling the International Critical Tables and the good that would be derived from them.

The next meeting will be held on February 6, 1926, in Baltimore, Md.

Pacific Northwest Section

Announcement is made of a joint meeting of the Pacific Northwest Section of the AMERICAN CERAMIC SOCIETY, the Clayworkers' Association and the Pacific Northwest Brick Manufacturers' Association to be held at Seattle on January 22 and 23, 1926.

---

[1] D. H. Fuller, Secy.

RESOLUTION ADOPTED AT GENERAL MEETING OF THE NATIONAL TERRA COTTA SOCIETY

Washington, D.C., November 14, 1925

Whereas, it seems highly desirable to bring about a closer relationship between the technical and executive branches of the terra cotta industry and

Whereas, Ross C. Purdy has at this meeting presented to the Society a plan approved by the Board of Directors of the AMERICAN CERAMIC SOCIETY, whereby such results might be accomplished, not only for the Terra Cotta Industry but for other Clay Working Industries as well and

Whereas, said plan will in due time no doubt be presented to other Trade Associations for their consideration, be it

Resolved, that the National Terra Cotta Society go on record as being in sympathy with the plan or such modification of same as further development may bring about, and hereby instruct and authorize its Executive Committee to take whatever action may be necessary in the future to further the movement.

Be it also further resolved, that a copy of this resolution be forwarded to the General Secretary of the AMERICAN CERAMIC SOCIETY, for whatever use he may see fit to make of same.

OBITUARY

William E. Vodrey

Word has been received of the death of William E. Vodrey of the Vodrey Pottery Company of East Liverpool, Ohio. Mr. Vodrey was an active member of the AMERICAN CERAMIC SOCIETY and this announcement will be read with regret by his many friends in the SOCIETY.

CONTRIBUTORS DURING 1925 TO THE WORK OF THE SOCIETY

The AMERICAN CERAMIC SOCIETY is not a self-perpetuating institution. It is dependent all the while on the personal members for its character and life; the SOCIETY is thereby the means and result of cooperation of the personal members to further their own interests in particular by increasing in general the ceramic research and educational facilities. That this can be done most effectively, our members must know one another and for this purpose we have each January and throughout the year presented a facsimile and a biographical sketch of those who have served in this coöperative enterprise during the year 1925.

D. F. Albery.* Comm. on Papers and Program, Terra Cotta Div.
F. B. Allen.* Contribution, "Better Terra Cotta Slabs," *Journal*, February, pp. 101-107.
Olaf Andersen.* Abstractor.

Louis S. Anderson.* Contribution: "Comparison of Methods in Estimating the Maturing of Terra Cotta," *Journal*, November, pp. 762-67.

Andrew Irving Andrews. *Bulletin* **4** [10] 562 (1925). Contribution: Co author with G. A. Bole and J. R. Withrow, "The Making of Dolomite Brick and a Study of Their Properties," *Journal*, Pt. I., Feb. pp. 82-100; Pt. II, March, pp. 171-90.

H. C. ARNOLD

R. E. ARNOLD

Howard C. Arnold. Born Chicago, Ill., 1891. B.S. (ceramic engineering) Univ. of Ill., 1914. M.A. (Physical chemistry and optical mineralogy), Ohio State Univ., 1916. Secy., Chemical Supply and Construction Co., 1914-16. Instructor, Ceramic Eng., Univ. of Ill., 1916-17. 1st Lieut. Research Division, Chemical Warfare Service, 1917-19. Ceramic chemist, B. F. Drakenfeld and Co., N.Y., 1919-21. Ceramic chemist, Arthur D. Little, Inc., Cambridge, Mass., 1921-24. Consulting ceramic chemist, 1924 to date. Member AMERICAN CERAMIC SOCIETY, 1920—. Comm. on Data, Heavy Clay Products Div. Also member Am. Electrochem. Soc., A.C.S., A.A.A.S., A.I.M.M.E., Soc. Glass Technology.

E. P. ARTHUR

Russell E. Arnold. Born Chicago, Ill., 1898. B.S. (ceramic engineering) Univ. of Ill., 1922. Made study of Bristol glaze compositions, White Hall Sewer Pipe and Stoneware Co., 1922 (summer). In charge of electrical porcelain research, Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa., 1922-25. Senior Industrial Fellow, Vitrified Clay Products Fellowship, Mellon Institute, Feb. 1925, to date. Member, AMERICAN CERAMIC SOCIETY, 1923—. Comm. on Data, Heavy Clay Products Div.

Edwin P. Arthur. Born Cripple Creek, Colo., 1899. Wilmington Coll., 1917. Graduated Ohio State Univ., 1922. Asst. County Engineer, Clinton Co., Ohio. Asst. Chemist,

NOTE: A *Journal* or *Bulletin* reference which follows name immediately indicates that photograph and biographical sketch have appeared in earlier issues.
Names with * indicates that photograph and sketch will appear later.

U.S. Sheet and Window Glass Co., Shreveport, La. Pittsburgh Sheet Glass Co., Washington, Pa. U. S. Glass Co., Morgantown, W. Va. Glass technologist and consulting engineer. To date, graduate student, chemical engineering, Ohio State Univ. Member AMERICAN CERAMIC SOCIETY, 1923—. Contribution: "Limestone for Sheet Glass Making," *Journal*, March, pp. 125-30.

A. A. AYARS

Alice A. Ayars. Born Richburg, N.Y. Graduate, N.Y. State School of Clayworking and Ceramics, 1919. (B.S. in applied art.) Teacher of pottery at the Stockbridge Pottery, Stockbridge, Mass., 1920-21. Teacher of pottery, Hazen Craft School, Gloucester, Mass., summer, 1923. Glazing and firing pottery for Senior High School, Cleveland, Ohio, 1922 to date. Member, AMERICAN CERAMIC SOCIETY, 1923—. Abstractor.

E. E. Ayars. *Bulletin* **3** [3] 100 (1924). Editor: Question Box, Refractories Div.

R. BACK

Robert Back. Born Chicago, Ill., 1889. B.S. (ceramic engineering) Univ. of Ill., 1913. U.S. Bur. of Mines, ceramic research, 1912-15, Urbana Ill., Pittsburgh, Pa. and Washington, D.C. Ceramic lab. asst., Univ. of Ill., 1912-13. Associated in business with father, 1916-19. Supt., the Haeger Potteries, Dundee, Ill., 1919-20. Ceramic engineer and chemist, The Wahl Co., Eversharp and Pencils and Fountain Pens, supt. of lead dept., 1920 to date. Member, AMERICAN CERAMIC SOCIETY, 1912—. Contribution: "The Manufacture of Leads for the Mechanical Pencil," *Bulletin*, November, pp. 571-79. Also member A.C.S.

H. C. BALDWIN

Arthur Baggs. *Bulletin* **3** [1] 13 (1924). Comm. on Rules, Art Div.

Cecil E. Bales. *Bulletin* **3** [1] 13 (1924). Comm. on Divisions and Sections. Chairman, Refractories Div. Abstractor.

H. Clinton Baldwin. Born Lakemont, N.Y., 1902. B.S. (ceramic engineering) N.Y. State School of Clayworking and Ceramics, 1923. Development and service work, Ceramic color dept., Roessler and Hasslacher Chemical Co., 1923 to date. Member, AMERICAN CERAMIC SOCIETY, 1923—. Secy., Art. Div.

Edward Phillip Barrett. Born Fort McPherson, Neb., 1883. B.S., Mo. School of Mines and Metallurgy, 1909: Met. Eng., 1924. Instructor in chemistry, Mo. School of Mines, 1909-10. Instructor in Chemistry, Okla. School of Mines. 1910-11. Instructor in Mining Okla. School of

Mines, 1911-12. Acting president, Okla. School of Mines, 1913-15. Chemist, U.S. Bur. Mines, Salt Lake City, Utah, and Seattle, Wash., 1915-19. Metallurgical chemist U.S. Bur. Mines, chloride volatilization, Salt Lake, 1920-21. Asst. Metallurgist, U.S. Bur. Mines, Seattle, Wash., 1921-24. Acting supt., N.W. Expt. Sta. U.S. Bur. Mines, Seattle, 1924. Acting Chief, Metallurgy Section, U.S. Bur. Mines, Pittsburgh, Pa., Feb.-July, 1925. Metallurgist, U.S. Bur. Mines, Minneapolis, Minn., July, 1925 to date. Contribution: "Method for the Analysis of Aluminous Silicate Refractories," *Journal*, January, pp. 69-71.

E. P. BARRETT

Wayne E. Barrett. Born Coon Rapids, Carroll Co., Iowa, December, 1899. B.S. (ceramic engineering) Iowa State Coll., 1922. Three years and to date, engineer, Adel Clay Products Co., Adel, Iowa. Contributions:"Laboratory Experiments in the Development of a Plant Drier," *Journal*, April, pp. 239-42; "Glazes Colored by Molybdenum," *Journal*, May, p. 306. "A Home Made Jolley," *Bulletin*, May, p. 209.

W. E. BARRETT

L. E. Barringer. *Journal*, **6** [1] 41. Associate Editor, *Journal;* Comm. on Rules.

G. E. Barton. *Bulletin*, **3** [4] 131 (1924). Councillor, Glass Div.

F. E. Bausch. *Bulletin* **3** [1] 13 (1924). Chairman, and on Executive Comm., St. Louis Section.

M. F. Beecher.* Comm. on Standards (Definitions) and Comm. on Rules; AMERICAN CERAMIC SOCIETY; Comm. on Nominations, New England Section.

A. L. BENNETT

W. J. Benner.* Vice-Chairman, Chicago Section.

A. Lee Bennett. Born Silver Creek, N.Y., 1898. B.S. (chemical engineering) Univ. of Wash., 1920. M.S. (ceramics) Univ. of Wash., 1922. Formerly connected with the U.S. Bur. Mines, Seattle, Wash., in charge of chemical lab. Ceramist, Northern Clay Co., and Gladding McBean and Co., to date. Member AMERICAN CERAMIC SOCIETY, 1922—. Member, Board of Trustees Pacific Northwest Clayworkers Assn. and Section of the AMERICAN CERAMIC SOCIETY.

C. W. Berry.* Chairman, Program Comm., and on Executive Comm., St. Louis Section.

C. F. Binns. *Journal* **6** [1] 23 (1923); *Bulletin*, **4** [7] 333 (1925). Comm. on Standards (Tests), Art Div. Contribution: "E Concrematione Confirmato," *Bulletin*, July, pp. 334-39.

Marion W. Blair. *Bulletin*, **4** [1] 5 (1925). Rep. Comm. on Nominations, Heavy

Clay Products Div. Contribution: "Research Results Applied to the Plant, Why, When and How," *Bulletin*, June, pp. 283-86.

A. V. Bleininger. *Bulletin* **1** [7] 64 (1922); *Journal* **6** [1] 24 (1923). Comm. on Research, White Wares Div.

E. P. CARSON

G. A. Bole. *Bulletin* **1** [1] 333 (1922), *Journal* **6** [1] 154 (1923). Comm. on Geological Survey. Comm. on Contact, Heavy Clay Products Div. Comm. on Standards (Tests and Products) White Wares Div. Co-author with A. I. Andrews and J. W. Withrow, "The Making of Dolomite Brick and a Study of Their Properties," *Journal*, February, Pt.I. pp.84-100; Pt.II., March, pp. 171-90. "Study of Kiln Losses—An example of Value Accrued from Coöperative Research," *Bulletin*, August, pp. 352-59.

M. C. Booze. *Bulletin* **4** [1] 6 (1925). Comm. on Standards (Raw Materials), AMERICAN CERAMIC SOCIETY. Contributions: "The Effect of Red Hearts in Fire Clay Brick," *Journal*, April, pp. 227-31; Co-author with S. M. Phelps, "A Study of the Factors Involved in the Spalling of Fire Clay Refractories with Some Notes on the Load and Reheating Tests and the Effect of Grind on Shrinkage," *Journal*, June, pp. 361-82. "The Chemical and Physical Properties of Fire Clays from Various Producing Districts," *Journal*, October, pp. 655-65.

R. F. Brenner.* Comm. on Standards (Tests), Glass Div.

Margaret K. Cable. *Bulletin* **4** [1] 8, **4** [3] 119 (1925). Vice Chairman, Art Division; Editor Question Box. Contribution: "Pots and Pines, A Decorative Problem for the Artist Potter," *Journal*, June, pp. 393-95.

A. M. Campbell.* Comm. on Geological Survey.

Frederick G. Carder. *Bulletin* **3** [1] 16 (1924). Councillor, Art Div.

Edna P. Carson. Born Pittsburgh, Pa. Student, Arts and crafts course, Carnegie Inst., 1910-14. Univ. of Pittsburgh, 1919-21. Summer school, Alfred Univ., 1920. Art teacher, Fort Pitt High School, Pittsburgh, Pa., 1914-17. Art supervisor, Pittsburgh Public Shcools, 1917-20. Teacher of modeling and pottery, Schenley High School, Pittsburgh, Pa., 1920 to date. Investigation work in clays and ceramic problems suitable for high schools. Member, AMERICAN CERAMIC SOCIETY, 1920—. Comm. on Education, Art Div.

E. J. CASSELMAN

Elbridge J. Casselman. Born Washington, D.C., 1893. B.S. (chemical engineering) Mass. Inst. Tech. Eight years chemical engineering experience in paper, steel, fertilizer and synthetic resin industries. Industrial Fellow, Mellon Institute, 2 years and to date. Member, AMERICAN CERAMIC SOCIETY, 1923—. Chairman, Pittsburgh Section.

J. L. Child.* Comm. on Coöperation, Heavy Clay Products Div.

R. L. Clare. *Journal* **6** [1] 56 (1923). Trustee, Terra Cotta Div. Associate Editor, *Journal*. Comm. on Research.

H. H. Clark. *Bulletin* **4** [1] 8 (1925). Contribution: "Gas Fired Enameling Furnaces," *Journal*, October, pp. 623-25.

W. M. Clark. *Journal* **6** [1] 58 (1923). Chairman, Comm. on Research. Comm. on Contact, Glass Div. Executive Comm., Northern Ohio Section. Abstractor.

S. S. Cole. *Bulletin* **4** [1] 8 (1925). Contributions: "European Silica Refractories," *Journal*, January, pp. 55-58. "A Note on Comparison of English vs. Orton Pyrometric Cones," *Journal*, July, p. 462.

D. W. Cox

D. W. Cox. Born near Indianapolis, January, 1849. Worked with stoneware about 10 years, Gas City, Indiana, and elsewhere. Contribution: "A Slip Painting Process Suited to the Craftsman Whose Equipment is Limited," *Journal*, May, pp. 310-12.

Paul E. Cox. *Journal* **6** [1] 105; *Bulletin* **4** [5] 118 (1925). Trustee. Councillor, Art Div. Contributions: "Fine Stoneware from Flint Clay," *Journal*, April, pp. 257-58. "Ceramic Extension at Iowa State College," *Bulletin*, August, pp. 369-72. "American Ceramics for Interior Decorating. The Silver Lining in the Cloud," *Bulletin*, September, pp. 418-23.

J. L. Crawford. *Bulletin* **3** [1] 17 (1924). Comm. on Nominations, St. Louis Section.

J. W. Cruikshank. *Bulletin* **4** [1] 9 (1925). Comm. on Data, Glass Div. Comm. on Nominations, Pittsburgh Section.

M. F. Cunningham.* Executive Comm., New England Section.

E. R. Curry.* Contribution: Co-author with P. G. Larkin, "Notes on Terra Cotta Body Shrinkage," *Journal*, February, pp. 113-14.

E. DEF. CURTIS

Edmund de Forest Curtis. Born Brooklyn, N.Y., 1884. Attended Harvard College, 1906. Mining at Cripple Creek, three years. Reorganized the old Van Briggle Pottery, Colorado Springs, and operated it three years. Manager Enfield Tile and Pottery, Enfield, Pa., several years. During the War, supt. blast furnace. For 4 years, operated small shop, making lamp bases. Instructor in pottery at the Pennsylvania Museum and School of Industrial Art, 3 years and to date. One summer, Alfred Univ. Contribution: "The Course in Pottery at the Pennsylvania Museum and School of Industrial Art," *Journal*, March, pp. 138-42.

T. S. Curtis.* Chairman, and on Comm. on Constitution and By-Laws, California Section. Contribution: "Synthetic Sillimanite in Ceramic Bodies," *Journal*, January, pp. 63-68.

R. R. Danielson, *Journal* **6** [1] 52 (1923). Comm. on Research. Trustee. Comm. on Rules. Rep. Comm. on Nominations, Enamel Div. Associate Editor, *Journal*.

W. A. Darrah. Born Providence, R. I., 1887. B.S. and E.E. Advanced courses in chemistry, ceramics, electrical engineering and physics. Manager, lighting engineering dept., Westinghouse Electric and Mfg. Co., E. Pittsburgh, Pa. Manager, Engineering Ohio Brass Co., Mansfield, Ohio. Manager, Noble Electric Co., Heroult, Calif. Presi-

dent, Continental Industrial Engineers, Inc., Chicago, Ill. Member, AMERICAN CERAMIC SOCIETY, 1923—. Also member, A.C.S., A.S.M.E., A.I.E.E., etc. Contribution: "The Vitreous Sanitary Ware Industry," *Bulletin*, June, pp. 261-83.

W. R. DAVEY

Wheeler P. Davey. Born Cleveland, Ohio, March, 1886. A.B., Western Reserve Univ., 1906. M.S., Pennsylvania State Coll., 1911. Ph.D., Cornell Univ., 1914. High school teacher, physics and chemistry, 1906-09. Instructor in Physics, Penn. State Coll. 1910-11. Asst. in physics, research fellow, instructor in physics, Cornell Univ., 1912-14. Research physicist, Research lab., General Electric Co., Schenectady, N.Y. Member, A.C.S., Fellow, A.A.A.S., and Am. Phys. Soc. Contribution: Co-author with L. Navias," "Differentiation between Mullite and Sillimanite," *Journal*, October, pp. 640-47.

H. E. Davis. *Bulletin* **3** [1] 17 (1924). Comm. on Papers and Program, Terra Cotta Div. Secretary, and on Comm. on Program, California Section. Contribution: Co-author with J. S. Lathrop, "A Study of Slips for Standard Finish Terra Cotta, (Cones 4-5)." *Journal*, January, pp. 23-28.

F. W. Donahoe.* Rep. Comm. on Nominations, Refractories Div.

A. L. Donnenwirth. Born Bucyrus, Ohio, 1898. B.S. (ceramic engineering) Ohio State Univ., 1922. With Jeffery-Dewitt Insulator Co., Kenova, W. Va., 1922-23. Asst. ceramist, Westinghouse High Voltage Insulator Co., Derry, Pa., 1923-25. Ceramic engineer, A.C. Spark Plug Co., and Faience Tile Co., Flint, Mich., Sept., 1925, to date. Member, AMERICAN CERAMIC SOCIETY, 1922—. Contribution: Co-author with E. H. Fritz, "Some Observations in the Casting of Heavy Electrical Porcelains," *Journal*, September, pp. 547-54.

W. E. Dornbach. *Bulletin* **4** [1] 29 (1925). Comm. on Publication, *Journal*. Comm. on Education, Refractories Div. Comm. on Rules, AMERICAN CERAMIC SOCIETY.

Philip Dressler. Born London, England, 1893. Felsted School, Essex, England. Clan Coll., Cambridge, England. First class honors, Pts. I and II. Natural Science Trips. B.A., 1914. M.A., 1920. Employed by Dressler Tunnel Ovens, London, 1914-15. Universal Sanitary Mfg. Co., New Castle, Pa., 1915-17. Chief thermal engineer, American Dressler Tunnel Kilns, 1917, to date. Vice President same Company since 1923. Member, AMERICAN CERAMIC SOCIETY, 1917—. Comm. on Program, Northern Ohio Section. Contributions: "Adaptation of Tunnel and Car Kilns to Firing of Refractories," *Journal*, January, pp. 43-54. Co-author with L. T. Strommer, "The Use of Muffle Tunnel Kilns for the Arching of Plate Glass Pots," *Journal*, April, pp. 216-26.

P. DRESSLER

C. G. Eichlin.* Contribution: Co-author with A. Q. Tool, "Variations in Glass Caused by Heat Treatment," *Journal*, January, pp. 1-17.

Geo. P. Fackt. *Bulletin* **3** [1] 18 (1924). Comm. on Membership, Terra Cotta Div.

J. B. Ferguson.* Contribution: Co-author with J. W. Rebbeck and M. J. Mulligan, "The Electrolysis of Soda-Lime Glass, Pt. II," *Journal*, June, pp. 329-38.

R. F. Ferguson. *Bulletin* **3** [1] 19 (1924). Comm. on Research, Refractories Div. Comm. on Nominations, Pittsburgh Section.

A. N. Finn. *Bulletin* **3** [4] 132 (1924). Comm. on Papers and Program. Secretary, Glass Division. Vice Chairman, and on Membership Comm., Baltimore-Washington Section. Co-author with H. G. Thomson, Contribution: "The Density and Index of Refraction of Glass vs. Its Composition," *Journal*, August, pp. 505-513.

D. P. FORST

H. G. Fisk.* Abstractor.

F. C. Flint. *Bulletin* **3** [1] 19 (1924). Councillor and on Comm. on Papers and Program, Glass Div. Program Comm., Pittsburgh, Section. Publication Comm., *Journal*.

A. Foltz.* *Bulletin* **3** [1] 19 (1924). Contribution: "The Development of a Casting Body for Vitrified Sanitary Ware from American Materials," *Journal*, June, pp. 383-90.

E. H. FRITZ

Daniel Perry Forst. Born Tiffin, Ohio, 1890. Graduated, Princeton Univ. and took 3-year course in ceramic engineering, Ohio State Univ. Lieut. in Field Artillery overseas during War. Factory manager, Robertson Art Tile Co., Trenton, N. J., 1920 to date. Member, AMERICAN CERAMIC SOCIETY, 1912—. Rep., Comm. on Nominations, White Wares Div.

Myrtle Meritt French. *Bulletin* **3** [1] 20 (1924). Comm. on Papers and Program, Art Division. Contributions: "Further Experiments in the Problem of the Turquoise Alkaline Glaze," *Journal*, March, pp. 143-44. "Uses of Ceramics in Interior Decorating," *Bulletin*, September, pp. 415-18.

G. S. FULCHER

Edwin H. Fritz. Born Toledo, Ohio, 1895. B.S. (ceramic engineering) Ohio State Univ., 1917. Engineering dept., American Blower Co., Detroit, Mich. 6 months. Asst. ceramic engineer, Westinghouse High Voltage Insulator Co., Derry, Pa., 2 years. Ceramic engineer, same company, 6 years. Member, AMERICAN CERAMIC SOCIETY, 1917—. Comm. on Rules, White Wares Division. Contributions: "American Clays as Compared to English Clays in White Ware Bodies," *Journal*, April, pp. 253-56. Co-author with A. L. Donnenwirth, "Some Observations in the Casting of Heavy Electrical Porcelains," *Journal*, September, pp. 547-54.

Gordon Scott Fulcher. Born Evanston, Ill., 1884. B.S. and M.A., Northwestern Univ., 1901 and 1906. Ph.D., Clark Univ., 1906-08. Instructor in physics, Amherst

Coll., 1908-09. Instructor and Asst. Prof., Univ. of Wis., 1909-18. Experimental Engineer, U.S.A., 1918. Research Asst., National Research Council, 1919-20. Research physicist, Corning Glass Works, Corning, N.Y., 1920 to date. Editor, *Physical Review*, 1923-25. Research chiefly in spectroscopy and discharge through glass. Contribution: "Analysis of Recent Measurements of the Viscosity of Glasses," *Journal*, June, pp. 339-55.

R. R. FUSSELBAUGH

R. Reardon Fusselbaugh. Born Baltimore, Md., 1892. Graduate Baltimore Polytechnic Inst., 1914. Asst. Supt., Baltimore Enamel and Novelty Co., 1920-23. Asst. to B. T. Sweely, factory manager, in charge of enamels, 1923 to date. Member, AMERICAN CERAMIC SOCIETY, 1923—. Secy.-Treas., Program Comm., Executive Comm., Baltimore-Washington Section. Contribution: Co-author with B. T. Sweely, "A Method of Control for Dipping Flat Ware," *Journal*, May, pp. 303-306.

Robert Galbraith. Born Pine Bluff, Ark., 1899 B.S. (ceramic engineering) Univ. of Ill., 1923. Ceramic engineer, American Terra Cotta and Ceramic Co., Crystal Lake, Ill., 1923 to date. Member, AMERICAN CERAMIC SOCIETY, 1924—. Contribution, "Some Data on the Pulsichrometer," *Journal*, January, pp. 59-62.

S. L. Galpin.* *Bulletin* **4** [1] 10 (1925). Chairman, Comm. on Geological Survey.

T. W. Garve. *Bulletin* **3** [1] 21 (1924). Contribution: "Segregation in Bins," *Journal*, October, pp. 666-70.

C. F. Geiger. *Bulletin* **3** [1] 21 (1924). Comm. on Membership, Refractories Div.

S. Geijsbeek. *Journal* **6** [1] 26 (1923). Secretary and Councillor, Pacific Northwest Section.

R. F. Geller. *Bulletin* **3** [1] 21 (1924). Comm. on Standards. Vice Chairman, Refractories Div. Comm. on Coöperation, White Wares Div. Chairman, Program Comm., Baltimore-Washington Section. Contribution: Co-author with W. L. Pendergast, "The Laboratory Testing of Plastic Refractories," *Journal*, July, pp. 441-51.

A. C. Gerber. *Bulletin* **4** [1] 11 (1925). Contribution: "Casting Control," *Journal*, January, pp. 18-22.

James Gillinder. *Bulletin* **4** [1] 11 (1925). Comm. on Coöperation, Glass Div.

A. L. Gladding. Vice Chairman, California Section.

R. GALBRAITH

Ernest F. Goodner. Born Pierre, S. D., 1898. B.S. (chemical engineering) 1920. M.S. (ceramics) Univ. of Washington, 1921. U.S. Bur. of Mines, Fellowship (State Geol. Surv.) 1920-21, Seattle, Wash. Ceramic chemist, Washington Brick, Lime and Sewer Pipe Co., 1921-April, 1925. District manager, sales dept., same Company, Seattle, Wash., to date. Member, AMERICAN CERAMIC SOCIETY, 1921—. Comm. on Nominations, Pacific-Northwest Section.

A. F. Gorton. *Journal* **6** [1] 59 (1923). Program Committee, Chicago Section. Abstractor. Contribution: Co-author with W. H. Groves, "New Type of Oxyacetylene

Fusion Furnace with Notes on the Behavior of Refractories at Cone 40," *Journal*, November, pp. 768-73.

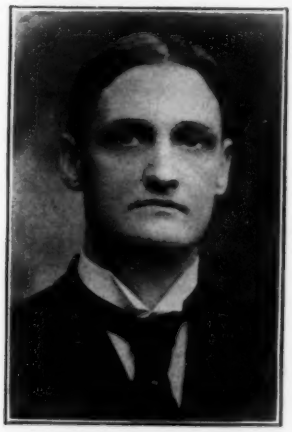
A. F. Greaves-Walker. *Journal* **6** [1] 44 (1923); *Bulletin* **3** [9] 356 (1924); *Bulletin* **4** [3] 123 (1925). Board of Trustees. Associate Editor, *Journal*. Contributions: "The Presidential Address, 1923," *Bulletin*, February, pp. 51-56. "Ceramic Engineering Correspondence Courses at N. Carolina State College" *Bulletin*, August, pp. 361-67.

J. R. GREEN

John R. Green. Born Chicago, Ill., 1900. B.S. (ceramic engineering) Univ. of Ill.,1922. Ceramic engineer, North Iowa Brick and Tile Co., Mason City, Iowa. Ceramic engineer, Brown Instrument Co., Indianapolis, Ind., to date. Contribution: "Getting the Highest Return from Kiln Equipment," *Journal*, September, pp. 599-604.

J. W. Greig. *Bulletin* **4** [1] 12 (1925). Contribution: "Formation of Mullite from Cyanite, Andalusite and Sillimanite," *Journal*, August, pp. 465-84.

John H. Griffith. Born Detroit, Mich., 1868. M.S., Univ. of Wis., 1898. Faculty, Univ. of Mich., 1907-11. Bur. of Standards, 1911-19. Prof. civil engineering, Iowa State Coll., to date. Member, A.S.C.E., Contribution: "On the Strength of Heavy Clay Products," *Journal*, February, pp. 108-12.



J. H. GRIFFITH

William H. Groves. Born Mt. Pulaski, Ill., 1896. General foreman, American Refractories Co., Joliet, Ill., 3 years. General foreman, Danville Refractories Co., Danville, Ill., 2 years. General foreman, General Refractories Co., Joliet, Ill., 4 years. Western Electric Company, development branch, working on refractories and furnaces, 4 years to date. Contribution: Co-author with A. F. Gorton, "New Type of Oxyacetylene Fusion Furnace with Notes on the Behavior of Refractories at Cone 40," *Journal*, November, pp. 768-73.

Earl Hagar.* Contribution: "Manufacture of Refractories by Dry Press Method," *Journal*, February, pp. 122-24.

J. E. Hansen, *Bulletin* **4** [1] 13 (1925). Comm. on Papers and Program, Enamel Div. Contribution: Co-author with G. S. Lindsey, "Observations on Hairlines in Sheet Iron Enamels," *Journal*, June, pp. 356-60.

J. M. Hammer.* Comm. on Membership, Glass Div.

A. C. Harrison.* Contribution: "A Machine for Transverse Tests of Clay and Glass Laboratory Specimens," *Journal*, November, pp. 774-83.

W. N. Harrison. *Bulletin* **4** [1] 13 (1925). Contribution: Co-author with H. G. Wolfram, "Effect of Composition on Properties of Sheet Steel Enamel." *Journal*, November, 735-55.

Miner L. Hartmann, Born Hutchinson, Kans. B.S., Univ. of Arizona. Ph.D., Harvard Univ. Director of Research, The Carborundum Co., Niagara Falls, N.Y. Member, AMERICAN CERAMIC SOCIETY, 1921—. Publication Comm., *Journal*. Contribution: Co-author with O. B. Westmont, "The Thermal Conductivity of Carborundum Refractories," *Journal*, May, pp. 259-95.

R. A. HEINDL

T. D. Hartshorn. *Bulletin* **3** [1] 23 (1924). Comm. on Data, Enamel Div.

G. H. Hays.* Secretary-Treasurer, Northern Ohio Section.

F. T. Heath. *Bulletin* **3** [1] 24 (1924). Contribution: "Bibliography and Abstracts on the Utilization of Pebbly Clays for Heavy Clay Products Manufacture," *Bulletin*, April, pp. 165-88.

Raymond A. Heindl. Born Marinette, Wis., 1892. B.S. (chemistry) George Washington Univ., 1917. Employed with Aluminum Co. of America, Carborundum Co., and International Abrasive Corp. Directing investigation on saggers and sagger clays, Bur. of Standards, 1922 to date. Contribution: "The Quantitative Determination of Iron Existing as Ferrosilicon in Artificial Corundum." *Journal*, October, pp. 671-76.

Perry D. Helser. *Bulletin* **3** [1] 24 (1924). Comm. on Coöperation, White Wares Div. Abstractor.

R. W. Hemphill.* Contribution: "Observations on Pinholing in Cast Ware," *Journal*, March, pp. 145-47.

H. B. Henderson. *Bulletin* **3** [3] 99 (1924). Treasurer, AMERICAN CERAMIC SOCIETY.

A. V. Henry. *Bulletin* **3** [1] 45 (1924); *Bulletin* **4** [3] 121 (1925). Comm. on Standards (Tests) Heavy Clay Producers Div. Contribution: "A Microscopic Study of Stresses in Glazes," *Journal*, February, pp. 117-21. "Coöperative Research in Ceramics," *Bulletin*, August, pp. 367-69.

H. W. Hess. *Bulletin* **3** [1] 24 (1924). Comm. on Education, Glass Div.

L. C. Hewitt. *Bulletin* **3** [1] 25 (1924). Secretary and on Comm. on Coöperation, Refractories Div. Comm. on Papers and Programs. Secretary-Treasurer, and on Executive Comm., St. Louis Section.

C. W. Hill. *Bulletin* **3** [1] 25 (1924). Comm. on Standards (Tests) Terra Cotta Div.

E. C. Hill. *Bulletin* **3** [1] 25 (1924). Comm. on Standards (Raw Materials) AMERICAN CERAMIC SOCIETY. Chairman, Terra Cotta Div. Comm. on Divisions and Sections.

C. J. HUDSON

Jane Hoagland. Member, AMERICAN CERAMIC SOCIETY, 1925–. Councillor, Art Div. Secy., N.Y. Society of Craftsmen, Art, Center, Inc., N.Y. City.

B. Mifflin Hood.* *Bulletin*, **5,** [1] 53 (1926). Comm. on Exhibitions, Heavy Clay Products Div.

Roy Horning. *Bulletin* **3** [1] 26 (1924). Associate Editor, *Journal*. Comm. on Membership, AMERICAN CERAMIC SOCIETY. Contribution: "Clay Storage," *Bulletin*, November, pp. 582-87.

J. C. Hostetter. *Journal* **6** [1] 54 (1923). Trustee, AMERICAN CERAMIC SOCIETY. Comm. on Program and Papers, Glass Div.

A. F. Hottinger. *Bulletin* **2** [9] 204 (1923); *Journal* **6** [1] 46 (1923). Comm. on Divisions and Sections. Comm. on Education, White Wares Div.

F. T. Houlahan.* Program Comm., Pacific-Northwest Section.

W. L. Howat.* Comm. on Standards (Products) Terra Cotta Div.

Charles J. Hudson. Born Clinton, Mass., 1886. B.A., Amherst Coll., 1910. M.A., Amherst Coll., 1911. Taught at Amherst, 1911-12. Taught at Univ. of Pittsburgh, 1912-17. Research Labs., Norton Co., Worcester, Mass., 1917 to date. Member, AMERICAN CERAMIC SOCIETY, 1917—. Abstractor.

W. A. Hull. *Journal* **6** [1] 58 (1923). Comm. on Rules, Terra Cotta Dvi.

H. A. Huisken.* Treasurer, California Section.

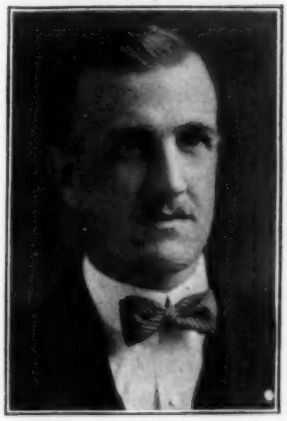
Herbert Insley. *Bulletin* **3** [1] 26 (1924). Vice Chairman, and on Comm. on Papers and Program, Glass Div. Chairman, and on Executive Comm., Baltimore-Washington Section. Contribution: "The Failure of Thermocouple Protection Tues in Glass Melting Furnaces," Journal, September, pp. 605-10.

F. G. Jackson. *Bulletin* **4** [1] 14 (1925). Abstractor. Comm. on Research, Heavy Clay Products Div. Contribution: "The Oxidation of Ceramic Wares during Firing VI. A Laboratory Study of the Effect of Varying the Rate of Gas Flow and of Heating on the Decomposition of Pyrite in Clay," *Journal*, August, pp. 534-40. "A Descriptive Bibliography of Scumming and Efflorescence," *Bulletin*, August, pp. 376-401.

F. G. Jaeger. *Journal* **6** [1] 60 (1923). Program Comm., St. Louis Section.

R. B. KEELER

Rufus B. Keeler. Born Bellingham, Wash., 1885. Special ceramic course, Univ. of Ill., 1910. Began clay work in 1900. Terra cotta and tile manufacturer, to date. Member, AMERICAN CERAMIC SOCIETY, 1909—. Contribution: "The Use of Clay Products in Modern Homes," *Bulletin*, July, pp. 310-20.



W. V. KNOWLES

A. W. Kimes. *Journal* **6** [1] 139 (1923). Rep. Comm. on Nominations, Glass Div. Comm. on Nominations, Pittsburgh Section.

R. M. King. *Bulletin* **4** [1] 27 (1925). Abstractor.

H. S. Kirk. *Journal* **6** [1] 52 (1923). Rep. Comm. on Nominations. Comm. on Data, Art Div.

A. A. Klein. *Bulletin* **3** [1] 17 (1924). Councillor and on Comm. on Nominations, New England Section.

T. A. Klinefelter. *Journal* **6** [1] 59 (1923). Comm. on Data, Terra Cotta Div.

William V. Knowles. Born Fort Davis, Texas, 1888. Chemist, Aluminum Company of America, Niagara Falls, 6 years. Chemist, Titanium Alloy Mfg. Co., 4 ½ years. Chicago district manager, same Company, 10 years. Member, AMERICAN CERAMIC SOCIETY, 1920—. Comm. on Exhibitions, Enamel Division; Chairman, Chicago Section.

Fred A. Kohlmeyer. Born St. Louis, Mo., 1891. B.S. (mechanical engineering) Washington Univ., 1913. In charge of research lab. of the Detroit Edison Co., 3 years. Engineer, purchasing dept., same Company. Contribution: "Selection of Fire Brick by Comparative Tests with a Detailed Description of the Method Used to Measure the Temporary Expansion or Contraction of Fire Brick at Various Temperatures," *Journal*, May, pp. 313-18.

F. A. KOHLMEYER

Seiji Kondo.* Abstractor.

Hobart M. Kraner. *Bulletin* **4** [1] 15 (1925). Contribution: Co-author with S. J. McDowell, "Talc as the Principle Body Ingredient in Vitrified Ceramic Bodies," *Journal*, October, pp. 626-35. Contribution: Co-author with S. J. McDowell, "The Effect of Heat on the Strength of Calcined Kieselguhr-Portland Cement Mixture." *Journal*, November, pp. 784-88.

H. R. Kreitzer.* Program Comm., Pacific-Northwest Section.

A. I. Krynitsky. Born, Russia, 1880. Graduated from Michael Artillery Coll., 1902, Michael Artillery Academy, 1907. Asst. supt. and supt. of the metallurgical dept. of time fuzes plant, Petrograd, Russia, 1907-15. Chief inspector of time fuzes, ordered in this country by Russian govt., 1915-18. Asst. physicist and associate physicist, Bur. of Standards, Washington, D.C., 1918 to date. Contribution: "Enameling Defects Due to Cast Iron," *Journal*, October, pp. 618-22.

A. I. KRYNITSKY

Adolph H. Kuechler. Born, Columbus, Ohio, 1902. B.S. (ceramic engineering) Ohio State Univ., 1924. M.S., Univ. of Mo., 1925. Plant experience summers, 1922 and 1923. Coöperative research fellowship, U.S. Bur. of Mines and Univ. of Mo., 1924-25. Junior ceramic engineer, U.S. Bur. of Mines, Rolla, Mo., to date. Member, AMERICAN CERAMIC SOCIETY, 1924—. Abstractor.

A. H. KUECHLER

R. D. Landrum. *Journal* **6** [1] 47 (1923). Trustee. AMERICAN CERAMIC SOCIETY. Councillor, Northern Ohio Section. Contributions: "What the Industries Want from the Ceramic Scientist," *Bulletin*, February, pp. 36-40; "Address of the Retiring President," *Bulletin*, March, pp. 103-112.

Karl E. Langenbeck. *Journal* **6** [1] 27 (1923). Contributions: "The Early Stages of the Science of Ceramics in America," *Bulletin*, July, pp. 306-309. "An Ideal Endeavor in Science and Art," *Bulletin*, Sept., pp. 423-25.

Paul Gifford Larkin. Born Pennsville, Ohio, 1889. B.S. (ceramics) Ohio State Univ., 1915. Ceramic engineer, The Denver Terra Cotta Co, 1915-19.. Ceramist, Gladding-McBean and Co., Lincoln, Calif., 1919 to date. Member, AMERICAN CERAMIC SOCIETY, 1916—. Comm. on Coöperation, Terra Cotta Div., Contribution: Co-author with E. R. Curry, "Notes on Terra Cotta Body Shrinkage," *Journal*, February, pp. 113-14.

P. G. LARKIN

John S. Lathrop. *Bulletin* **4** [1] 16 (1925). Contritribution: Co-author with H. E. Davis, "A Study of Slips for Standard Finish Terra Cotta (Cones 4-5)," *Journal*, January, pp. 23-28.

F. S. Laurence.* Contribution: "Terra Cotta in Architectural Design," *Journal*, February, pp. 79-83.

W. E. LEMLEY

C. H. Lawson. *Bulletin* **3** [1] 28 (1924). Secretary-Treasurer, New England Section.

Stephen Leech.* Comm. on Coöperation, White Wares Div.

Richard D. Leitch. *Bulletin* **3** [1] 16 (1924). Abstractor.

W. E. Lemley. Born near McPherson, Kans., 1881. Received education in state of Washington. Taught school 4 years. Entered employ of Denny Clay Co., (Denny-Renton Clay and Coal Co.), Seattle, 1902 to date. General supt. of mines and mfg. plant of Denny-Renton Clay and Coal Co., Taylor Washington, to date. Member, AMERICAN CERAMIC SOCIETY, 1919—. Comm. on Nominations, Pacific-Northwest Section.

D. C. Lindsay.* Contribution: Co-author with W. H. Wadleigh, "Some Observations on the Drying Properties of Clays," *Journal*, November, pp. 677-93.

G. S. Lindsey.* Contribution: Co-author with J. E. Hansen, "Observations on 'Hairlines' in Sheet Iron Enamels," *Journal*, June, pp. 356-60.

R. LINTON

Robert Linton. Washington and Jefferson Coll. Special work (metallurgy and ceramics) Imp. Polytechnic, Charlottenburg, Germany, two years asst. supt. R. C. Schmertz Glass Co. Same company absorbed by American Window Glass Co. Made supt. of Belle Vernon Works. Later asst. to chairman of the Company with general supervision of operations and engineering work in all factories. Mining engineering firm, Atwater, Linton and Atwater, 1906. President, North Butte Mining Co., 1918-23. Gen. manager, Pacific Clay Products Co., Los Angeles, Calif., 1923 to date. Played important rôle in adapting

the automatic blowing machine to practical factory conditions. Chairman, Comm. on Indus. Relations, A.I.M.E., 5 years. Comm. on Elimination of Waste in Industry, appointed by Herbert Hoover. President of Federated American Eng. Societies. Member, AMERICAN CERAMIC SOCIETY, 1924—. Vice Chairman, Calif. Section. Also member, A.S.C.E., A.I.M.M.E., Brit. I.M.M.

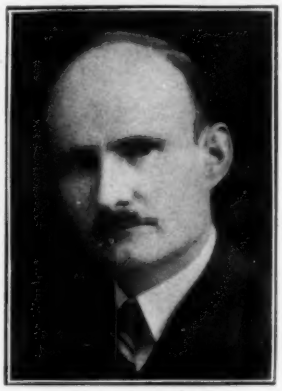
J. T. Littleton, Jr. *Bulletin* **3** [1] 29 (1924). Abstractor.

Russell N. Long. Born Spring Mills, Pa., 1894. B.S. (ceramic engineering) Ohio State Univ., 1918. Asst. ceramic engineer, U.S. Bur. of Mines, Columbus Station, 1918-20. Ceramic Chemist, 1920. Federal Terra Cotta Co., Woodbridge, N.J., 1920 to date. Member, AMERICAN CERAMIC SOCIETY, 1919—. Comm. on Contact, Terra Cotta Div.

R. N. LONG

Ellis Lovejoy. *Journal* **6** [1] 28 (1923). Contribution: "Theory of Coal Measure Fire Clays," *Journal*, November, pp. 756-61.

Harry J. Lucas. Born, Washington, D.C., 1871. Began career in terra cotta business in 1890 with N.Y. company successively serving as clerk, stenographer, bookkeeper, purchasing agent, assistant to superintendent, assistant treasurer, vice president and sales manager. Manager, National Terra Cotta Society, 1912-15. Vice-president and general manager, Northwestern Terra Cotta Co., Chicago, Ill., 1915 to date. Member, AMERICAN CERAMIC SOCIETY, 1910—. Councillor, Terra Cotta Div.



R. MACDOUGALL

W. Keith McAfee. Born Pittsburgh, Pa., 1893. B.S. (electrical engineering) Univ. of Pa., 1915. Transit man, State of Pa. Graduate student apprentice, motor design engineer, production clerk, service engineer, Westinghouse Electric and Mfg. Co. Gang foreman, engine house foreman, Pa. R.R. Engineer Universal Sanitary Mfg. Co., New Castle, Pa. Vice-president and manager, Cambridge Sanitary Mfg. Co., Cambridge, Ohio. Member, AMERICAN CERAMIC SOCIETY, 1923—. Chairman, Comm. on Education. Contribution: "Balling in Cast Ware," *Journal*, July, p. 430. Secy.-Treas., Ohio Ceramic Industries Assn.

W. K. MCAFEE

Atholl McBean. Councillor, Terra Cotta Div.

George V. McCauley. Born, Perryville, Mo., 1882. B.S., Northwestern Univ., 1908. M.A., 1909, Ph.D., Univ. of Wis., 1911. Teacher, Northwestern Univ., 1911-17. Physicist, Corning Glass Works, Corning, N.Y., 1918 to date. Member, AMERICAN CERAMIC SOCIETY, 1920—. Contribution: "Fundamentals of Heat Flow in Molten Glass and in Walls for Use against Glass," *Journal*, August, pp. 493-504.

Robert McDougall. Born Chicago, Ill., 1892. Two years college, mechanical engineering and designing. Experience in management, development of manufacturing processes and labor-saving machinery, 14 years. Co-inventor with H. C. Beasley, Coonley Mfg. Co., successful development of a continuous burning furnace for enamelware. In charge of enamel manuf., and plant engineer, Coonley Mfg. Co., Cicero, Ill., to date. Contribution: "Recuperator Oil Smelter," *Journal*, August, pp. 541-45.

G. V. McCauley

J. Spotts McDowell. *Journal* **6** [1] 55 (1923). Comm. on Standards (Definitions), American Ceramic Society, Trustee, Refractories Div. Program Comm., Pittsburgh Section.

Samuel J. McDowell. Born Bloomingburg, Ohio, 1894. B.S. (ceramic engineering) Ohio State Univ., 1917. Ceramic engineer, Detroit Star Grinding Wheel Co., 1917. Ceramic engineer, A. C. Spark Plug Co., 1917-25. Ceramic engineer, U.S. Bur. of Mines, Columbus, Ohio, 1925 to date. Member, American Ceramic Society, 1917—. Contributions: Co-author with H. M. Kraner, "Talc as the Principle Body Ingredient in Vitrified Ceramic Bodies," *Journal*, October, pp. 626-35. Co-author with H. M. Kraner, "The Effect of Heat on the Strength of Calcined Kieselguhr-Portland Cement Mixtures," *Journal*, November, pp. 784-88.

S. J. McDowell

H. B. McMillen. Born Pittsburgh, Pa. Potter's trade, Macomb, Ill. Graduated in ceramics, Ohio State Univ., 1905. Engaged in stoneware and terra cotta manufacture. Ceramic chemist (terra cotta department) Denny-Renton Clay and Coal Co., Seattle, Wash., 1921 to date. Member, American Ceramic Society, 1921—. Treasurer, Pacific Northwest Section.

H. B. McMillen

D. J. McSwiney.* Contribution: "The Action of Arsenic Compounds on Tank Block," *Journal*, May, pp. 307-309.

James T. MacKenzie.* Contribution: "The Effect of Variations in Cupola Practice on the Life of Refractory Blocks," *Journal*, November, pp. 720-34.

P. S. MacMichael.* Program Comm., Pacific-Northwest Section.

A. Malinovszky. *Bulletin* **3** [1] 29 (1924). Contribution: "Enameling Defects Due to the Cast Iron," *Journal*, January, pp. 72-78.

L. W. Manion.* Comm. on Membership, Northern Ohio Section.

T. S. Mann.* Comm. on Membership, Pacific-Northwest Section.

M. E. Manson. *Bulletin* **3** [1] 29 (1924). Comm. on Sections and Div. Chairman' Enamel Div. Contribution: "Some Notes on the Color of Antimony Enamels," *Journal* July, pp. 437-40. Abstractor.

John D. Martin. *Bulletin* **3** [1] 30 (1924). Comm. on Divisions and Sections. Chairman, Heavy Clay Products Div. Contribution: "Kiln Stokers," *Journal*, June, pp. 396-400.

Oscar Mathiasen.* Comm. on Papers and Program, Terra Cotta Div.

H. B. Matzen.* Contribution: Co-author with A. E. Stacey, Jr., "Ceramic Driers and Drying," *Journal*, August, pp. 525-33.

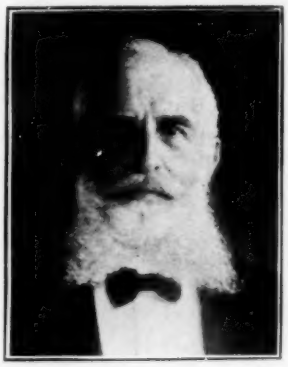
L. H. Menne.* Comm. on Membership, Chicago Section.

L. D. Mercer.* Comm. on Program, Northern Ohio Section.

C. A. Millar.* Contribution: "Methods and Manufacture of Sewer Pipe in Canada," *Journal*, July, pp. 452-57.

C. H. Modes.* Comm. on Program, St. Louis Section.

Richard Moldenke. Born Watertown, Wis., 1864. B.S. (engineer of mines) Columbia, Univ., 1885. Ph.D., 1887. Organized mechanical and electrical engineering department of Mich. Coll. of Mines, Houghton, Mich., 1889. Metallurgist, McConway and Torley Co., Pittsburgh, Pa. Supt., Pa. Malleable Co., Pittsburgh, Pa. Secy., American Foundryman's Assn., 1900-14. Adviser to Bethlehem Steel Co., Corn Products Refining Co., and semi-official connection with U.S. Bur. of Mines. Member, A.F.A., Inst. Brit. Foundryman, A.S.T.M., A.S.M.E., Brit. Iron and Steel Inst., German Verein Deut. Eisenhüttenleute. Given Joseph S. Seaman gold medal by A.F.A., 1925, in recognition of contributions to foundry industry. Contribution: "Refractory Requirements in the Gray Iron Industry," *Journal*, November, pp. 712-19.



R. MOLDENKE

R. J. Montgomery. *Bulletin* **3** [1] 30 (1924). Abstractor. Contribution: "Present and Future Walls for Use against Molten Glass," *Journal*, April, pp. 205-15. "A Test for Determining the Welding Properties of Glasses," *Bulletin*, May, pp. 210-11.

M. J. MULLIGAN

D. A. Moulton. *Bulletin* **3** [1] 31 (1924). Contribution: "Progress Report on Research of Paving Brick from Iowa Shales," *Journal*, November, pp. 694-701.

Maurice J. Mulligan. Born Corunna, Ont., Can., 1900. B.A., 1923, M.A., 1924, post-grad. work in chemistry, Univ. of Toronto. Physical chemical research. Holder of studentship from the Honorary and Advisory Council for Scientific and Industrial Research, Ottawa, Can. Contribution: Co-author with J. W. Rebbeck and J. B. Ferguson, "The Electrolysis of Soda-Lime Glass," Pt. II, *Journal*, June, pp. 329-38.

Louis Navias. *Bulletin* **3** [1] 31 (1924). Abstractor. Contributions: "Quantitative Determination of the Development of Mullite in Fired Clays by an X-Ray Method," *Journal*, May, pp. 296-302. "Study of Segregation in Porcelain Filter Cake by Petrographic Methods," *Journal*, July, pp. 432-36. Co-author with

Wheeler P. Davey, "Differentiation between Mullite and Sillimanite," *Journal*, October, pp. 640-47.

C. E. Nesbitt.* Vice Chairman, Pittsburgh Section.

F. P. Nickerson. *Bulletin* **3** [1] 32 (1924). Comm. on Membership, Northern Ohio Section.

F. H. Norton. *Bulletin* **4** [1] 19 (1925). "A General Theory of Spalling," *Journal*, January, pp. 29-39.

John Torrey Norton. Born Bedford, Mass., 1898. B.S. (physics) Mass. Inst. Tech., 1918. Research associate in physics, M.I.T., 1920-25. Asst. prof. of physics, 1925 to date. Specializing in X-ray work. Member, American Physical Society. Contributions: "An X-Ray Study of Natural and Artificial Sillimanite" *Journal*, July, pp. 401-406. "An X-Ray Study of Cyanite and Andalusite," *Journal*, October, pp. 636-39.

J. T. NORTON

O. P. R. Ogilvie. *Bulletin* **4** [1] 19 (1925). Abstractor.

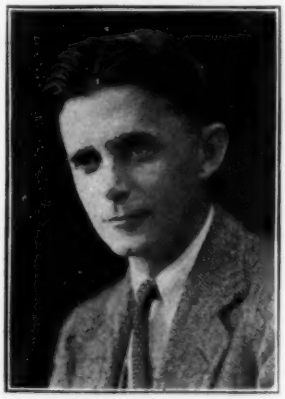
F. B. Ortman. *Journal* **6** [1] 49 (1923). Rep. Comm. on Nominations, Terra Cotta Div. Councillor, California Section. Comm. on Membership, AMERICAN CERAMIC SOCIETY.

Edward Orton, Jr. *Journal* **6** [1] 30 (1923); *Bulletin* **1** [7] 64-66 (1922). Contribution: "The Beginnings of Ceramic Education in the United States," *Bulletin*, March, pp. 89-96.

F. T. Owens. *Bulletin* **3** [1] 32 (1924). Comm. on Papers and Program, Heavy Clay Products Div. Comm. on Sections and Divisions.

C. W. Parmelee. *Bulletin* **1** [9] 215 (1922); *Journal* **6** [1] 40 (1923); *Bulletin* **4** [3] 116 (1925). Councillor, Chicago Section. Chairman, Comm. on Data. AMERICAN CERAMIC SOCIETY.

D. E. Parsons.* Comm. on Nominations, Baltimore-Washington Section.



W. L. PENDERGAST

A. R. Payne. *Bulletin* **3** [1] 32 (1924). Comm. on Research. Comm. on Exhibitions, Glass Div.

A. B. Peck. *Bulletin* **3** [1] 33 (1924). Chairman, Detroit Section. Contribution: "Changes in the Constitution and Microstructure of Andalusite, Cyanite and Sillimanite at High Temperature and Their Significance in Industrial Practice," *Journal*, July, pp. 407-29.

F. K. Pence. *Journal* **6** [1] 43 (1923). Chairman, Publication Comm., *Journal*.

William L. Pendergast. Born, Great Barrington, Mass. Grad. Georgetown Coll., 1918. Bacteriological dept., U.S. Army during War. Ceramic division, U.S. Bur. of Standards, Washington, D.C., 5 years to date. Member, AMERICAN CERAMIC SOCIETY, 1923—. Contributions: "An Electric Furnace for Softening Point Determination," *Journal*, May, pp. 319-25. Co-author with R. F. Geller, "The Laboratory Testing of Plastic Refractories," *Journal*, July, pp. 441-51.

S. M. Phelps.* Contribution: Co-author with M. C. Booze, "A Study of the Factors Involved in the Spalling of Fire Clay Refractories with Some Notes on the Load and Reheating Tests and the Effect of Grind on Shrinkage," *Journal*, June, pp. 361-82.

"The Relation of Structure and Composition to Thermal Efficiency of Refractories When Used in Regenerators," *Journal*, October, pp. 648-54.

Emerson P. Poste. *Journal* **6** [1] 53 (1923). Comm. on Divisions and Sections. Comm. on Standards, (Tests), Enamel Div. Vice Chairman and Comm. on Nominations, Northern Ohio Section. Contribution: "An Analysis of the Suspension of Enamel by Clay in Terms of the Colloid Theory," *Journal*, April, pp. 232-38.

Amos P. Potts. *Bulletin* **3** [1] 33 (1924). Secretary, Heavy Clay Products Div. Comm. on Papers and Program, AMERICAN CERAMIC SOCIETY.

W. H. Powell.* Councillor, Terra Cotta Div.

E. E. Pressler. *Bulletin* **4** [1] 20 (1925). Abstractor.

R. C. Purdy. *Journal* **6** [1] 38 (1923). General Secretary and Editor, AMERICAN CERAMIC SOCIETY. Comm. on Publications, *Journal*. Chairman, Comm. on Papers and Program. Contributions: "Vocational Training in Ceramics," *Bulletin*, August, pp. 372-74. "American Ceramics," *Bulletin*, September, pp. 425-26.

J. W. REBBECK

B. S. Radcliffe.* Comm. on Exhibitions, Terra Cotta Div.

N. A. Ragland.* Contribution: "Rapid Check-Testing for Feldspar for Use in Vitrified Floor Tile," *Journal*, June, pp. 391-92.

J. W. Rebbeck. Born Victoria, B.C., Can., 1898. B.S. (chemical engineering) Univ. of Brit. Columbia. M.A., Univ. of Toronto. Physical chemical research. Demonstrator, chemical engineering and applied science, Univ. of Toronto. Member, Soc. Chem. Indus., Can. Inst. of Chemistry. Contribution: Co-author with M. J. Mulligan and J. B. Ferguson, "The Electrolysis of Soda-Lime Glass," Pt. II, *Journal*, June, pp. 329-38.

W. J. Rees.* Contribution: "The Changes Which Take Place in Silica Brick during Their Use in Open-Hearth Furnace," *Journal*, January, pp. 40-42.

F. H. Rhead. *Journal* **6** [1] 51 (1923). Vice President, AMERICAN CERAMIC SOCIETY. Secretary and Comm. on Program and Papers, White Wares Division; Comm. on Research and Comm. on Standards, (Products), Art Division. Associate Editor, *Journal*. Contribution: "What the Industries Want from the Ceramic Artist," *Bulletin*, April, pp. 158-64.

W. D. Richardson. *Journal* **6** [1] 32 (1923). Comm. on Rules, Heavy Clay Products Div. Contribution: "Saving Fuel in Firing Common Brick," *Bulletin*, June, pp. 254-60.

Gisela M. A. Richter. Born London, Eng., 1882. Girton Coll., Cambridge, Eng. Brit. School of Archaeology, Athens, Greece, M.A. and Litt.D. Curator of classical art., Metropolitan Museum of Art, N.Y. City. Contribution: "Dynamic Symmetry as Applied to Pottery," *Journal*, March, pp. 131-37.

V. J. ROEHM

F. H. Riddle. *Journal* **6** [1] 43 (1923). Comm. on Divisions and Sections. Chairman, White Wares Div. Councillor, Detroit Section. Contribution: "Presidential Address—1922," *Bulletin*, February, pp. 44-45.

H. Ries. *Journal* **6** [1] 33 (1923). Comm. on Geological Survey. Associate Editor, *Journal*. Contribution: "Bibliography of Clay Deposts," *Bulletin*, September, pp. 428-510.

F. G. Roberts. *Bulletin* **4** [1] 21 (1925). Vice Chairman, and on Executive Comm., Baltimore–Washington Section.

H. F. Robertson.* Secretary, Pittsburgh Section.

J. T. Robson. *Bulletin* **4** [1] 22 (1925). Contribution: "A Modern Brick Plant," *Journal*, March, pp. 159-70.

Victor Jerome Roehm. Born Columbus, Ohio, 1895. B.S. (chemical engineering) Ohio State Univ., 1920. Asst. chemist, Homer-Laughlin China Co., 2 years. Fellow, U.S. Potters' Assn. to determine factors influencing crazing, U.S. Bur. of Standards, Washington, D.C., 18 months. Supt. of kilns at new No. 6 Plant, Homer-Laughlin China Co., Newell, W. Va., to date. Contribution: "Notes on the Operation of Direct-Fired Tunnel Kilns," *Journal*, August, pp. 514-24.

B. W. Rogers.* Contribution: "Rubber Grinding Mill Linings and Rubber as a Material to Resist Abrasion," *Journal*, May, pp. 326-28.

P. H. SANBORN

D. W. Ross. *Bulletin* **4** [1] 22 (1925). Comm. on Data, Refractories Div. Comm. on Standards (Raw Materials) AMERICAN CERAMIC SOCIETY.

H. F. Royal. *Bulletin* **4** [1] 22 (1925). Secretary-Treasurer, and Comm. on Nominations, Detroit Section.

W. SCHMIDT

Paul H. Sanborn. Born Huntington, W. Va. 1897. Chemical engineering, W. Va., Univ. Special work, Yale Univ. Chief chemist, Basic Products Co., Kenova, W. Va. (Work on high tension porcelain.) Member, AMERICAN CERAMIC SOCIETY, 1923—. Also member of A.C.S. Contribution: "Slip Making and Control," *Journal*, September, pp. 555-64.

T. H. Sant. *Bulletin* **4** [1] 23 (1925). Treasurer, Pittsburgh Section.

John Sawyer.* Comm. on Membership, California Section.

Walter Schmidt. Born Auerbach, Saxony, 1897. Tech. Hochschule, Berlin, Charlottenburg. Plant engineer, Rheinmetal, Düsseldorf, 1 year. Investigator, Siemens-Schukert-Werke, Berlin, 2 years. Research labs., Champion Porcelain Co., Detroit, Mich. 2 years and to date. Abstractor.

S. R. Scholes. *Bulletin* **4** [10] 562 (1925). Comm. on Rules, Glass Division.

E. Schramm. *Bulletin* **4** [1] 23 (1925). Comm. on Data, White Wares Div. Co-author with E. W. Scripture, Jr. Contribution: "The Particle Analysis of Clays by Sedimentation," *Journal*, April, pp. 24-52.

F. W. Schroeder. *Bulletin* **4** [1] 23 (1925). Contribution: Co-author with E. P. Barrett, "Method for the Analysis of Aluminous Silicate Refractories," *Journal*, January, pp. 69-71.

H. G. Schurecht. *Bulletin* **1** [9] 216 (1922); *Journal* **6** [1] 172 (1923). Abstractor.

E. W. Scripture, Jr.* Contribution: Co-author with E. Schramm, "The Particle Analysis of Clays by Sedimentation," *Journal*, April, pp. 243-52.

Donald E. Sharp. *Bulletin* **4** [1] 24 (1925). Abstractor.

Mary G. Sheerer. *Bulletin* **3** [1] 35 (1924). Chairman, Art Division. Comm. on Divisions and Sections.

T. A. Shegog. *Bulletin* **4** [1] 24 (1925). Comm. on Papers and Program, White Wares Div. Contribution: "Some Forms of Sulphuring on Earthenware Glazes," *Journal*, March, pp. 148-53.

Robert F. Sherwood. Born Hornell, N.Y., 1897. B.S. (ceramic engineering), N.Y. State School of Clay Working and Ceramics at Alfred Univ., 1920. Ceramic div., U.S. Bur. of Standards, Pittsburgh and Washington, D.C., $2\frac{1}{2}$ years. Clay Products Co., Muncie, Ind. Ceramic engineer, Pass and Seymour, Inc., Solvay, N.Y. Member, AMERICAN CERAMIC SOCIETY, 1919—. Contributions: "Medieval European Pottery," *Bulletin*, May, pp. 211-18. "A Method for Determining the Life of a Sagger," *Bulletin*, July, pp. 323-26.

R. R. Shively.* Chairman, Comm. on Membership, AMERICAN CERAMIC SOCIETY. Editor Question Box, Glass Division.

A. Silverman. *Journal* **6** [1] 61 (1923). Chairman, Glass Division. Chairman, Comm. on Divisions and Sections.

George Simcoe. Born North East, Md., 1876. Short course (ceramics) Ohio State Univ., 1902. Research on high tension insulator bodies, Univ. of Ill., 1910. At bench, Cook Pottery Co., Trenton, N.J. As presser and jiggerman, 3 years. Washing kaolin, Maryland Clay Co., North East, Md., 6 months. Supt. Plant, No. 2, Locke Insulator Co., Victor, N.Y., 3 years. Supt., the Electric Porcelain and Mfg. Co., Trenton, N.J., 9 years. Organizing and operating the Octagon Insulator and Mfg. Co., North East Md., 2 years. Worked for short periods with the Empire China Co., Brooklyn, N.Y., Empire Floor and Wall Tile Co., Metuchen, N.J., M. B. Valentine and Bros. Co., Woodbridge, N.J., and Perth Amboy, N.J. Edgar Bros. Co., Metuchen, N.J., to date. Member, AMERICAN CERAMIC SOCIETY, 1906—. Comm. on Membership, White Wares Division.

Geo. Sladek.* Comm. on Standards (Tests) White Wares Div.

R. B. Sosman.* Contribution: "Some Fundamental Principles Governing the Corrosion of a Fire Clay Refractory by Glass," *Journal*, April, pp. 191-204.

Ira T. Sproat. *Bulletin* **3** [1] 36 (1924). Comm. on Membership, White Wares Div.

Alfred E. Stacey, Jr. Born Elbridge, N.Y., 1885. B.S. (mechanical engineering) Syracuse Univ., 1906. Asst. chemical engineer, Buffalo Forge Co., 1906-07. Chemical engineer, Carrier Air Cond. Co., 1907-09. Western manager, Carrier Engineering Co., 1915-19. Research engineer, Carrier Engineering Corp., 1919 to date. Contributions: "Theory of Evaporation with Special Reference to the Effect of Air Velocity and of Moisture." *Journal*, July, pp. 457-61. Co-author with H. B. Matzen, "Ceramic Driers and Drying," *Journal*, August, pp. 525-33.

A. E. STACEY, JR.

H. F. Staley. *Journal* **6** [1] 42 (1923). Comm. on Research, Enamel Division. Abstractor.

F. L. Steinhoff. *Bulletin* **3** [1] 37 (1924). Comm. on Sections and Divisions. Comm. on Nominations, Chicago Section.

W. J. Stephani. *Bulletin* **3** [1] 37 (1924). Vice Chairman, Terra Cotta Div. Comm. on Rules, AMERICAN CERAMIC SOCIETY.

H. H. Stephenson. *Bulletin* **4** [1] 26 (1925). Abstractor.

G. T. Stowe.* Comm. on Program, Northern Ohio Section.

H. R. Straight. *Bulletin* **4** [1] 26 (1925). Comm. on Education, Heavy Clay Products Div.

L. T. Strommer.* Contribution: Co-author with P. Dressler, "The Use of Muffle Tunnel Kilns for the "Arching" of Plate Glass Pots," *Journal*, April, pp. 216-26.

R. T. Stull. *Journal* **6** [1] 42 (1923). Comm. on Membership, AMERICAN CERAMIC SOCIETY.

B. T. Sweely. *Journal* **6** [1] 45 (1923). Councillor, Baltimore-Washington Section. Contribution: Co-author with R. R. Fusselbaugh, "A Method of Control of Enamel for Dipping Flat Wares," *Journal*, May, pp. 303-306.

Arthur P. Taylor.* Contribution: "Ideal Coöperation between the Universities and the Industries," *Bulletin*, February, pp. 40-42.

D. A. Tchernobaieff.* Contribution: "The Calculation of Coal Expense in Rotary Cement Kilns," *Journal*, November, pp. 702-707.

C. Forrest Tefft. *Journal* **6** [1] 55 (1923). Trustee, Heavy Clay Products Div.

Edmund J. Tepas. Born Cleveland, Ohio, 1892. B.S., Case School of Applied Science, Cleveland, Ohio. Glass Section, U.S. Bur. of Standards, Washington, D.C., 1923-24. Patent examiner, U.S. Patent Office, to date. Abstractor.

E. J. TEPAS

G. E. Thomas. *Bulletin* **3** [1] 38 (1924). Chairman, Membership Comm., and Executive Comm., St. Louis Section.

F. S. Thompson. *Bulletin* **3** [1] 38 (1924). Contribution: Co-author with H. I. Vormelker, "Some Features of Tank Block Comparison," *Journal*, October, pp. 611-17.

H. K. TURK

H. G. Thomson.* Contribution: Co-author with A. N. Finn, "The Density and Index of Refraction of Glass vs. Its Composition," *Journal*, August, pp. 505-513.

C. B. Thwing. *Bulletin* **3** [1] 39 (1924). Contribution: "The Use of Radiation Pyrometers on Refractory Kilns," *Journal*, February, pp. 115-16.

E. Ward Tillotson. *Bulletin* **1** [8] 121 (1922); *Journal* **6** [1] 46 (1923). President, AMERICAN CERAMIC SOCIETY. Associate Editor, *Journal*. Contribution: "The Future of Ceramic Education," *Bulletin*, March, pp. 100-103. "Industrial Research," *Bulletin*, August, pp. 359-60.

A. Q. Tool.* Contribution: Co-author with C. G. Eichlin, "Variations in Glass Caused by Heat Treatment," *Journal*, January, pp. 1-17.

C. C. Treischel. *Journal* **6** [1] 56 (1923). Trustee and Comm. on Papers and Program, White Wares Div.

Louis J. Trostel. *Bulletin* **4** [1] 27 (1925). Comm. on Papers and Program, Refractories Div.

Gus M. Tucker. *Bulletin* **4** [1] 27 (1925). Secretary, Terra Cotta Div. Comm. on Papers and Program.

H. I. VORMELKER

Herbert Karl Turk. Born Baltimore, Md., 1906. Baltimore Polytechnic Inst., Chemistry at Johns Hopkins Univ. In charge of purchasing and production depts., Porcelain Enamel and Mfg. Co., to date. Member, AMERICAN CERAMIC SOCIETY, 1924–. Chairman, Membership Comm., Baltimore-Washington Section.

Karl Turk. *Bulletin* **3** [1] 39 (1924). Comm. on Nominations, Baltimore–Washington Section.

Robt. Twells, Jr. *Bulletin* **3** [1] 39 (1924). Comm. on Standards, (Products) White Wares Div. Comm. on Membership, Detroit Section. Contribution: "Progress Report on the Use of Andalusite as a Refractory," *Journal*, August, pp. 485-92.

H. I. Vormelker. Born Cleveland, Ohio, 1900. B.S., in metallurgical engineering. Ceramic engineer, National Lamp Works, General Electric Co., Nela Park, Cleveland, Ohio. Contribution: Co-author with F. S. Thompson, "Some Features of Tank Block Comparison," *Journal*, October, pp. 611-17.

W. Hiram Wadleigh. Born Markesan, Wis., 1873. Grad. Iowa State Teachers' Coll., 1900. Oberlin Coll., 2 years. B.S., 1907 and M.S., 1914, (physics and elec. engineering) Univ. of Mich. Taught physics and elec. engineering in college and universities 12 years. U.S. Bur. of Standards, 7 years: 2 years in ballistics, 4 years in charge of radium lab., 1 year on drying of clays, to date. Contribution: Co-author with D. C. Lindsay, "Some Observations on the Drying Properties of Clays," *Journal*, November, pp. 677-93.

B. F. WAGNER

Bruce F. Wagner. Born Northwood, Iowa, 1901. B.S. (ceramic engineering) Iowa State Coll., 1923. With Coonley Mfg. Co., Cicero, Ill. Member, AMERICAN CERAMIC SOCIETY, 1922–. Secy.-Treasurer, Chicago Section.

A. S. Walden.* Executive Comm., Northern Ohio Section.

F. W. Walker. *Journal* **6** [1] 34 (1923). Councillor, Pittsburgh Section.

E. W. Washburn. *Bulletin* **1** [7] 58 (1922); *Journal* **6** [1] 48 (1923). Comm. on Research, Glass Div.

A. S. Watts. *Journal* **6** [1] 39 (1923); *Bulletin* **4** [3] 113 (1925). Comm. on Standards (Definitions). AMERICA CERAMIC SOCIETY. Contribution: "The Development of a Ceramic Course, to Meet the Demands of the Industry," *Bulletin*, February, pp. 42-44.

R. A. Weaver. *Bulletin* **3** [1] 41 (1924). Comm. on Membership, Enamel Div. Comm. on Membership, Northern Ohio Section.

Martha Q. Westfeldt. Comm. on Exhibitions, Art Division.

Albert E. R. Westman. Born Ottawa, Can., 1900-B.A. (honor chemistry) Univ. of Toronto. M.A.. Ph.D., (Physical chemistry and electrical engineering,Univ. of Toronto. Asst., electric furnace labs., Univ. of Toronto. Refractories research, Carborundun Co. Research Associate in ceramics, Eng. Expt. Sta., Univ. of Ill., to date. Member, AMERICAN CERAMIC SOCIETY, 1924–. Abstractor.

A. E. R. WESTMAN

O. B. Westmont. Born Richmond, Ill., 1898. B.S. (chemical engineering) Univ. of Wis., 1921. Research chemist, The Carborundum Co., Niagara Falls, N.Y., 1921 to date. Contribution: Co-author with M. L. Hartmann, "The Thermal Conductivity of Carborundum Refractories," *Journal*, May, pp. 259-95.

F. A. Whitaker. *Bulletin* **4** [1] 28 (1925). Abstractor

A. M. White.* Contribution: "Common Stoneware Decorated by the China Painter's Process," *Bulletin* May, pp. 220-221.

O. B. WESTMONT

J. D. Whitmer.* Comm. on Rules, AMERICAN CERAMIC SOCIETY.

O. J. Whittemore.* Councillor, Heavy Clay Products Division. Contribution: "Plant Management Methods," *Bulletin*, November, pp. 587-95.

W. W. Wilkins.* Comm. on Membership, Art Div.

H. G. Willetts.* Entertainment Comm., Pittsburgh, Section.

A. E. Williams. *Journal* **6** [1] 53 (1923). Comm. on Standards (Products) and Councillor, Glass Division.

B. W. Willson.* Contribution: "Designing Bands for Round Kiln Crowns," *Journal*, March, pp. 154-58.

M. L. YANCEY

Hewitt Wilson. *Journal* **6** [1] 111 (1923); *Bulletin* **4** (3) 120 (1925). Comm. on Membership, AMERICAN CERAMIC SOCIETY. Editor: Question Box, Terra Cotta Div. Comm. on Standards (Products) Heavy Clay Products Div. Chairman, Pacific Northwest Section.

J. W. Withrow. *Bulletin* **4** [1] 29 (1925). Contribution: Co-author with A. I. Andrews and G. A. Bole, "The Making of Dolomite Brick and a Study of Their Properties," *Journal*, Pt. I, Feb., pp. 84-100, Pt. II, March, pp. 171-90.

H. G. Wolfram. *Bulletin* **3** [3] 99 (1924). Secretary, Enamel Division. Comm. on Papers and Program. Contribution: Co-author with W. N. Harrison, "Effects of Composition on Properties of Sheet Steel Enamel." *Journal*, November, pp. 735-55.

Ellsworth Woodward.* Contribution: "Reflections upon Art and Manufacture," *Bulletin*, May, pp. 218-20.

W. G. Worcester. *Journal* **6** [1] 107 (1923); *Bulletin* **4** [3] 121 (1925). Comm. on Geological Survey.

Mary Lanier Yancey. Born Birmingham, Ala. Art course, Newcomb Coll., Bachelor of Design, Tulane Univ. Teacher of arts and crafts, Cincinnati High School, 2 years. Teacher of pottery making, 1 year. Member, AMERICAN CERAMIC SOCIETY, 1925—. Contribution: "Conventional vs. Naturalistic Design," *Bulletin*, July, pp. 321-23.

A. S. Zopfi. *Bulletin* **3** [1] 44 (1924). Chairman, Northern Ohio Section.

NOTES AND NEWS

NOTES FROM CERAMIC SCHOOLS

University of Toronto to Give Short Course in Ceramics

It is proposed to hold an extension course in ceramics at the University of Toronto, January 18 to 29, 1926. Full particulars of the course may be obtained by writing for the December *Bulletin* of the Canadian National Clay Products Association. Fee for the full course of forty or more lectures will be $2.00.

To Request Chair of Ceramic Engineering at Rolla

Representatives of the Missouri Refractories Association and of the Missouri Clay Association held a meeting in Rolla, Mo., on November 30, 1925, for the purpose of requesting the School of Mines and Metallurgy to establish a chair of ceramic engineering.

A. M. Menzi of St. Louis, secretary of the Refractories Association, pointed out that in point of value the clay and other ceramic industries of Missouri rank third in the mineral products of the state. Missouri ranks first among the states, from the standpoint of tonnage produced, and third in point of value, with the industry growing at a rapid rate. The clay industries are having to go out of the State for trained ceramic engineers and Missouri boys desiring to study this branch of engineering are having to go outside the State for such training. Also, research problems relating purely to Missouri clays are being neglected.

The school officials have taken the matter under advisement, and further meetings will be held in the near future.

Those present at the meeting, outside of school officials, were

L. U. Nichols and C. O. McNamee, Fulton Fire Brick Co., Fulton, Mo.
J. H. Keiger, General Manager, Wellsville Fire Brick Co., Wellsville, Mo.
A. M. Menzi, Secretary, Missouri Refractories Association, St. Louis
J. H. Kruson, President, and J. Harrison Brown, Secretary, both of the A. P. Green Fire Brick Co., Mexico, Mo.

Ceramics in Wheeling, W. Va. High School

The ceramics work done in the high school at Wheeling, W. Va., begins in the eighth grade or Junior High class for one semester of eighteen weeks, one hour and twenty minutes per week. This course, taught by Thomas Parker, has one hundred and forty students enrolled at this time.

OUTLINE OF EIGHTH GRADE COURSE

(1) Study of clays used in the manufacture, kinds of clay, where found and their uses. (2) Bench work in pressing small paper-weights and tea-pot tiles. (3) Bench work in casting small pieces. (4) Pressing handles. (5) Sticking up or handling. (6) Finishing, or getting ware ready for first or biscuit kilns.

The boys are instructed in a course of ceramic design and applications such as are adaptable for small pieces to be cut or incised.

The boys are instructed in a course of ceramic design and applications such as

Pottery No. 1. Casting rose-bowl design and application of same. Casting straight jar design and application of same. Throwing and turning of tea-pot-design and application of same.

Pottery No. 2. Throwing and turning of a 5-inch bowl, 7-inch bowl and 7-inch vase.

Pottery No. 3. Throwing larger vase or lamp base. Pressing wall vase or wall sconce in fire-clay design to be built up in relief. Throwing and turning a 9-inch bowl.

Pottery No. 4. Making of small dinner ware such as fruits and small plates with spreading machine and jigger. Placing biscuit kiln. Placing glost kiln. Study of pyrometric cones. Arrangement of cones. Kiln firing.

The shop equipment of this school consists of four throwing wheels, two turning lathes, one spreading machine, one jigger, one double ball mill, fifteen bench wheels, the necessary molds, damp-box, one Drakenfeld, an $8.00 pottery kiln and one Drakenfeld. One $3.00 decorating kiln. The raw material such as clays, stone, grog, etc., are supplied free through the kindness of the Warwick China Company.

Modeling and Design to be Taught at East Liverpool

A class in clay modeling and designing will be added to the ceramic classes in the East Liverpool high school. This announcement was made recently by Kenneth Smith, supervisor of the classes. B. L. Watkin[1] will be available as instructor for this work. The tuition for the twelve weeks training will be $2.00.

BUREAU OF MINES NOTES

Making Plastic Magnesia

Methods of making satisfactory plastic magnesia, used extensively in the manufacture of stucco and composition flooring, from the magnesite deposits of the western states have been developed as the result of an investigation conducted by the Bureau of Mines, Department of Commerce. The investigation also revealed that plastic magnesia of fair quality could be produced from dolomite, a material cheaply obtainable in the eastern states, where the market for plastic magnesia is largest. The experimental work of the Bureau of Mines was conducted with magnesite from Washington and California, with the view of aiding American producers in establishing a domestic industry to compete with material heretofore largely imported.

The first commercial use of magnesian cements was in Germany, the Bureau of Mines points out in a report just issued. Their use in the United States was just being established at the beginning of the world war, but is gaining rapidly at present. Most of the plastic magnesia now made from domestic magnesite comes from California producers.

---

[1] For photograph and sketch of B. L. Watkin see *Bull. Amer. Ceram. Soc.*, **4** [10] 559 (1925).

Magnesia stucco has gained headway in competition with cement stucco largely because it makes a stronger, harder, and more elastic cement which adheres more firmly to wood surfaces and takes and holds dashes of ornamental colored pebbles as well as other stuccos. This stucco gives a house a more finished appearance, probably due to the colored pebbles, but it has one disadvantage—it is not as weatherproof as cement stucco. Weatherproofing compounds are therefore being tried. The structural firmness and density of the stucco are the qualities that best insure protection, and these qualities largely depend on the quality of the plastic magnesia used, which in turn depends mainly on selecting suitable raw material and accurately controlling the proper calcining temperature. Judged from the cumulative experience of the industry, properly made magnesian stucco is resistant enough to weathering to be considered entirely satisfactory.

Composition floors, if properly laid, are quite satisfactory. They are permanent, warm to the touch, elastic, fireproof and fairly ornamental, and can be laid over old or new wooden floors. Bathroom floors and walls are now quite often covered with the composition and bathtubs are frequently encased in it. Slabs of the same material, often appropriately tinted, are used for drainboards in kitchen sinks and for similar purposes.

Interior plaster made with plastic magnesia offers a field as yet little exploited. Other uses for the material will doubtless develop. At present manufacturers of composition flooring and of stucco buy plastic magnesia and prepare mixtures that are ready to be moistened with magnesium chloride solution at the point of application. Formerly the supply of plastic magnesia was variable and occasionally bad, but this condition is now rapidly improving.

Recarbonation of free lime in burned dolomite or plastic magnesia, in order that these materials will yield satisfactory magnesian cements, has proved of great value for dolomites, but of doubtful value for magnesites, although they are benefited to some extent.

The big centers of consumption of plastic magnesia are in the Eastern States, whereas the only producing districts of the country are in California and Washington. On the other hand, large supplies of good dolomite are available in the East and the Bureau of Mines tests have shown that recarbonated dolomite makes very satisfactory stuccoes. Dolomite does not contain enough magnesia for flooring cements. However, since 80 per cent of the plastic magnesia sold is used for stucco, recarbonated calcined dolomite could satisfactorily supply most of the demand for plastic magnesia.

Research undertaken to show the suitability of Washington crystalline magnesite for the manufacture of plastic magnesia, while accomplishing its purpose definitely and satisfactorily, incidentally discovered a process for using dolomite in magnesian mortars which may well prove commercially important. This discovery indicates a use for vast deposits of pure dolomite near eastern consuming centers and may revolutionize the magnesian mortar industry.

The results of this investigation are contained in Bureau of Mines, *Bulletin*, **236**, "Plastic magnesia," By OLIVER C. RALSTON, ROBERT D. PIKE, and LIONEL H. DUSCHAK, copies of which may be obtained from the Superintendent of Documents, Washington, D.C., at a price of 30 cents.

PROMOTIONS OF SPECIFICATIONS BY TRADE ASSOCIATIONS

To what extent, and how rapidly, it will prove possible to convince manufacturers in general that a thoroughly organized standardization plan would be beneficial to them can not now be predicted. However, there are reasons for believing that many manufacturers who are not very enthusiastic over standardization can be shown by their

trade associations the value of standardization in their business—through mass operation in production, elimination of waste in manufacture and distribution, and minimizing of sales expenses. It is believed that the education of the manufacturers along these lines is a service that trade associations might well render to their members, with great benefit to the trade associations.

There are several ways in which industry, through representative trade associations, can become very active in the proposed certification plan for promoting the use of nationally recognized specifications.

(*a*) First of all is publicity by means of which the industry will be made acquainted with the real significance of the undertaking and shown the benefits to be derived from the plan if put into operation.

(*b*) Second, but of no less importance than the first, is thorough coöperation in the preparation of specifications that can most properly be referred to as nationally recognized.

(*c*) Next is coöperation in the plan by inducing all of the members of the Association to have their names included in the list of manufacturers willing to certify to the purchaser that the commodities supplied by them under nationally recognized specifications have been tested and found to comply with these specifications.

(*d*) Trade associations representing either dealers or manufacturers reaching consumers through retailers, can be of much help in showing the dealers and retailers how they (as both purchasers and sellers) will benefit from the plan.

(*e*) A final step for the trade association to take, when the time seems ripe for it to do so, is to make sure that its members are keeping faith so far as the certification plan is concerned.

Misrepresentation might be a proper subject for Federal Trade Commission action, but doubtless non-governmental agencies for accomplishing the same result would be even better. To what extent the various industries, through their trade associations, can do "policing" remains to be demonstrated, but it seems not to be essential for the Government to do "policing" work in order to make effective the proposed plan for promoting the use of nationally recognized specifications.

"CARBOPLASTIC" GUN

The Carborundum Company has a new cement called "Carboplastic" cement and a "Carboplastic" gun.

The principal ingredient of this new cement is silicon carbide. "Carboplastic" cement inherits the refractory properties of silicon carbide and lends itself readily to application with the "Carboplastic" gun. The cement is prepared for use by addition of water to give it the proper consistency. It air sets with a strong bond.

The principal uses for this cement are (1) resistance to localized flame impingment and (2) filling cavities developed in the brick work. By applying this cement as a coating over the fire brick face or as a plastic refractory for patching the life of fire brick settings is materially increased. It can be applied to either hot or cold settings.

The "Carboplastic" gun is portable, weighing but 12 pounds. It has no moving parts to get out of order and is operated by a single valve located close to the handle. The gun is operated by either steam or air at 100 pounds pressure. It can shoot fifty pounds of cement in less than half a minute.

SOCIETY OF GLASS TECHNOLOGY

A meeting of the Society of Glass Technology was held in the coal, gas and fuel industries department, The University, Leeds, on Wednesday, November 18, 1925, F. G. Clark, Vice President, in the chair. Four papers were presented.

Notes on Some Old Yorkshire Glasshouses. WILFRED R. BARKER. BARKER'S investigations supplemented those of JOSEPH KENWORTHY and FRANCIS BUCKLEY. The glasshouses to which particular attention was given were (1) The glasshouse at Gawber near Silkstone, which was probably one of the factories mentioned by John Houghton as in operation in 1696, (2) The Worsborough Dale Glasshouse, the forerunner of the present firm of Messrs. Wood Bros. & Co. Ltd., Barnsley, (3) The Glasshouse at Rothwell Haigh. Where possible the sites and remains of these old glasshouses had been visited, and examined. The paper was illustrated by numerous photographs.

Some Properties of Sillimanite Bricks and Kaolin-Sillimanite Mixtures. H. S. HOULDSWORTH. The addition of sillimanite to fire clay or kaolin decreased the drying and firing shrinkages and increased the porosity as well as the refractoriness of the mixtures containing fire clay. Kaolin was more resistant to the solvent action of a soda-lime glass than were were kaolin-sillimanite mixtures containing less than 60% of sillimanite. The best results were obtained with test pieces made from a mixture of 66⅔% 9% of sillimanite and 33⅓% of kaolin. The reversible thermal expansion of kaolin-sillimanite mixtures was regular and did not vary appreciably with variations in the percentage of sillimanite present. Some tests on commercial sillimanite bricks were also disussed.

Some Experiments with Sillimanite Pots for Glass Melting. A. COUSEN, S. ENGLISH, and W. E. S. TURNER. From the point of view of the glass manufacturer the question of resistance to corrosion by glass was generally regarded by the glass manufacturer as more important than any other. Experiments were made in which glass batch was melted in pots under specified conditions, and determinations of the alumina and ferric oxide in the glass were used as a measure of the extensiveness of corrosion. The experiments were carried out on two scales; (1) with small pots holding about a pound of glass; (2) with pots holding about 30 pounds of glass, and tested under continuous running conditions.

In the case of small pots, two series of glasses were employed, namely a soda-lime-silica glass, and a potash-lead oxide-silica glass, both of compositions similar to those widely employed in commerce. With the former series the main conclusion to be drawn was that the glass melted in sillimanite pots contained distinctly less iron oxide than when melted in ordinary fire-clay pots. For the potash-lead oxide glasses, the results were similar to those for the soda-lime glasses, the best results being obtained with fine sillimanite, or mixtures containing a preponderance of fine sillimanite. Here, also, the color of the glasses melted in sillimanite pots was not so marked as when melted in fire-clay pots.

The results obtained with the small pots were sufficiently assuring to warrant the preparation of larger pots: 30% ball clay with 70% sillimanite was adopted as the standard mixture. The sillimanite mixtures did not work up so easily as ordinary clay mixtures. Shrinkage from the drying state was very small, in fact almost negligible, even after firing at a temperature of 1500°C in the interior of the top of the pot. It was found that a pot could have its temperature reduced at the week-end to 600°C and be raised again on Monday to melting value without appreciable harm. A number of meltings of glasses of various kinds were made; 24 meltings in one pot and 20 in another. The general results confirmed those carried out on the smaller scale, the iron oxide content of the glasses being considerably lower than would be expected from fire-clay pots.

A Note on the Cause of Shot-Holing in Glasshouse Pots. PERCIVAL MARSON. An investigation into the cause for a series of pots failing early in their life owing to shot-holes forming in the lower angle at the bottom of the pots. The hole, no more than ¾ inch in diameter, took a course diagonally downwards through the very thickest portion of the pot, while the remainder of the pot was quite sound. It was eventually found that the batch of clay used for making these pots had been made too soon after wetting up. The plasticity of the clay not being fully developed, the layers of clay, even under the best efforts of the pot maker, failed to unite under the usual pressure of his hand, and this left boundaries along which glass might subsequently find its way.

Owing to lack of time, two other papers on the program were taken as read, namely: (*a*) "Note on a Design for a Glass Pot-Board", by Francis Winks. (*b*) "The Design of Tank Furnaces, A Criticism and Some Suggestions", by H. W. Howes.

CALENDAR OF CONVENTIONS

Amer. Assn. for Advancement of Science	Dec. 28-Jan. 2	Kansas City, Mo.
AMERICAN CERAMIC SOCIETY	Feb. 8-13, 1926	Atlanta, Ga.
American Chemical Society (Spring Meeting)	April 5-9, 1926	Tulsa, Okla.
American Concrete Institute	Feb. 23-26, 1926	Chicago, Ill.
Amer. Electrochemical Society	April 22-24, 1926	Chicago, Ill.
American Engineering Council	January, 1926	
American Foundrymen's Assn.	Sept. 27, 1926	Detroit, Mich.
Amer. Institute of Min. and Met. Engrs.	February 15, 1926	New York City
Amer. Soc. Steel Treating	Jan. 21-22, 1926	Buffalo, N.Y.
Amer. Soc. Testing Materials	June 21-26, 1926	Atlantic City, N.J.
Amer. Zinc Institute	April 27-28, 1926	St. Louis, Mo.
Assn. Chemical Equipment Mfrs.	May 10-15, 1926	Cleveland, Ohio.
Assn. Iron and Steel Mfrs.	May 31-June 5, 1926	Chicago, Ill.
Baltimore-Washington Section (American Ceramic Society)	Feb. 6, 1926	Baltimore, Md.
Canadian National Clay Products Assotion	Jan. 26-28, 1926	Toronto, Canada
Common Brick Manufacturers	February 22-26, 1926	New Orleans, La.
Hollow Building Tile Assn.	January, 1926	Chicago, Ill.
Manufacturing Chemists' Association	May or June, 1926	Near New York City
Natl. Acad. of Sciences (Spring Meeting)	April 26-28, 1926	Washington, D.C.
Natl. Assn. of Mfrs. of Pressed and Blown Glassware	March 9, 1926	Pittsburgh, Pa.
Natl. Assn. Stove Mfrs.	May 12-13, 1926	New York City
Natl. Paving Brick Mfrs. Assn.	January, 1926	
Natural Gas Assn. of America	May 17-20, 1926	Tulsa, Okla.
Sand-Lime Brick Assn.	Feb. 9-15, 1926	New Orleans, La.

WHO DO YOU TRY TO REACH

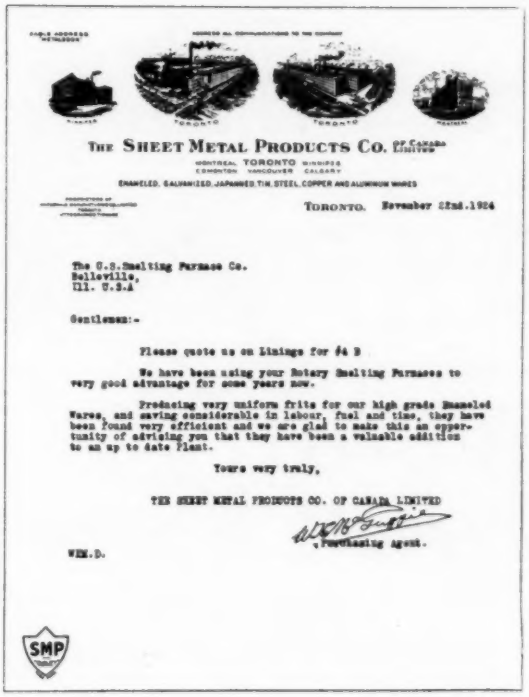
with your advertising? The kiln burner or the engineer in charge of the plant? The readers of the Journal make up the greater number of the engineers with whom you want to get in touch. By using Journal advertising space it identifies you and your product as being worthy. The trust placed in you by Journal readers means increased sales.

Advertising Department

American Ceramic Society

Lord Hall, O. S. U. **Columbus, Ohio**

LARGE CANADIAN ENAMELING PLANT USING BATTERY OF U. S. ROTARY ENAMEL SMELTING FURNACES



THE SHEET METAL PRODUCTS CO. OF CANADA LIMITED

MONTREAL TORONTO WINNIPEG EDMONTON VANCOUVER CALGARY

ENAMELLED, GALVANIZED, JAPANNED TIN, STEEL, COPPER AND ALUMINUM WARES

TORONTO, November 22nd. 1924

The U.S.Smelting Furnace Co.
Belleville,
Ill. U.S.A

Gentlemen:-

Please quote us on Linings for #4 B

We have been using your Rotary Smelting Furnaces to very good advantage for some years now.

Producing very uniform frits for our high grade Enameled Wares, and saving considerable in labour, fuel and time, they have been found very efficient and we are glad to make this an opportunity of advising you that they have been a valuable addition to an up to date Plant.

Yours very truly,

THE SHEET METAL PRODUCTS CO. OF CANADA LIMITED

Purchasing Agent.

WEM.D.

SMP

Years of Efficient Service

Very Uniform Frits at a Saving in Fuel, Labor and Time

A Valuable Addition

SIZES AND CAPACITIES

No. 1	No. 2	No. 3	No. 4	No. 4-B
60 lb.	150 lb.	350 lb.	750 lb.	1200 lb.

Description, Photographs, Specifications and Prices Mailed Promptly

THE U. S. SMELTING FURNACE CO.

BELLEVILLE. ILLINOIS, U. S. A.

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE

A

Air Compressors
General Electric Co.

Alumina (Hydrate and Calcined)
Harshaw, Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.

Alundum (Refratory Products)
Norton Co.

Auger Machines
Chambers Brothers Co.

Automatic Brick Machinery
Lancaster Iron Works, Inc.

Automatic Cutters
Chambers Brothers Co.

Automatic Stove Rooms
Philadelphia Drying Machinery Co.

Automatic Temperature Control
Engelhard, Chas., Inc.
Leeds & Northrup Co.

B

Ball Mills
Hardinge Co.
McDanel Refrac. Porcelain Co.
Mueller Machine Co., Inc.

Batts (Alundum-Crystolon)
Norton Co.

Bitstone
Potters Supply Co.

Bituminous Coal
Seaboard Fuel Corp.

Blocks (Refractory)
Norton Co.
Parker Russell Co.

Boats, Combustion
Norton Co.

Borax
American Trona Corp.
Innis, Speiden & Co.

Boric Acid (Crystal, Granular or Powder)
American Trona Corp.
Innis, Speiden & Co.

Brick Making Machinery
Chambers Brothers Co.

Bricks (Refractory-Alundum-Crystolon)
Norton Co.

Burners (Oil)
Best, W. N. Corp.

C

Cars (Clay)
Lancaster Iron Works, Inc.

Carbonates (Barium-Lead)
Innis, Speiden & Co.

Caustic Soda
Pennsylvania Salt Mfg. Co.

Cements
Norton Co.
Parker Russell Co.

Ceramic Chemicals
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Metal & Thermit Corp.
Paper Makers Importing Co., (Inc.)
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Ceramic Plant Equipment
Chambers Brothers Co.
Mueller Machine Co., Inc.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

Clay (Ball)
Harshaw, Fuller & Goodwin Co.
Paper Makers Importing Co.
Potters Supply Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (China)
Drakenfeld and Co., B. F.
Edgar Brothers Co.
Harshaw, Fuller & Goodwin Co.
Paper Makers Importing Co., (Inc.)
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Clay (Electrical—Porcelain)
Edgar Brothers Co.
Harshaw, Fuller & Goodwin Co.
Paper Makers Importing Co., (Inc.)
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Enamel)
Edgar Brothers Co.
Paper Makers Importing Co.
Metal & Thermit Corp.
United Clay Mines Corp.
Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co.
Paper Makers Importing Co., (Inc.)
Parker Russell Co.
Potters Supply Co.
United Clay Mines Corp.

Clay (Potters)
Paper Makers Importing Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

No, I haven't

I have not yet received a copy of your new catalog No. 25. Please send me a copy without any obligation on my part.

*Name*_____ *Firm*_____

*Address*_____

I am especially interested in:

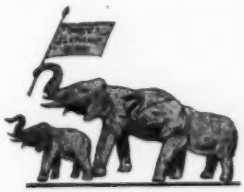
☐ Bran Duster grade wire cloth
☐ Tinned mill screen cloth ☐ brass ☐ copper
☐ bronze ☐ steel wire cloth
Market grade wire cloth ☐ Brass ☐ copper
☐ Extra fine phosphor bronze wire cloth
☐ Monel Metal wire cloth
☐ Nickel wire cloth
☐ Standard Testing Sieves

NEWARK
Trade Mark

Send us a sample of the wire cloth you want duplicated. We carry a very wide assortment in stock.

Newark Wire Cloth Co.
355-369 Verona Ave. Newark, N. J.
Branch Office;
66 Hamilton St., Cambridge, Mass.

THREE ELEPHANT BORAX
99.5% Pure



We also make Boric Acid, guaranteed 99.5% pure
Write us for specifications and price
AMERICAN TRONA CORPORATION
WOOLWORTH BLDG. NEW YORK CITY

Quality *Uniformity* *Service*
LUSTERLITE ENAMELS
MANUFACTURERS
FURNACES - - SPEED FORKS - - ENAMELS
Complete Enamel Shop Supplies and Equipment
STOCK CARRIED
Chicago Vitreous Enamel Product Company
1407-47 S. 55th Court, Cicero, Ill., U. S. A.

BUYERS' GUIDE (continued)

Clay (Sagger)
Edgar Brothers Co.
Paper Makers Importing Co., (Inc.)
Parker Russell Co.
Potters Supply Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay Cleaning Machinery
Lancaster Iron Works, Inc.

Clay Handling Machinery
Hadfield-Penfield Steel Co.
Mueller Machine Co., (Inc.)

Clay Miners
Edgar Brothers Co.
Paper Makers Importing Co., (Inc.)
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay Storage Systems
Lancaster Iron Works, Inc.

Clay (Wad)
Paper Makers Importing Co., (Inc.)
Potters Supply Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Wall Tile)
Papers Makers Importing Co., (Inc.)
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay Washing Machinery
Mueller Machine Co., Inc.

Clay Working Machinery
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Cloth (wire)
Newark Wire Cloth Co.

Coal-(Bituminous)—
Seaboard Fuel Corp.

Colors
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Conditioning Machinery
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

Cones (Filter)
Norton Co.

Conical Mills
Hardinge Co.

Controllers
General Electric Co.

Conveyors (Belt Cable)
Lancaster Iron Works, Inc.

Conveyors (Clay, Sand, Brick, etc.)
Hadfield-Penfield Steel Co.
Philadelphia Drying Machinery Co.
Mueller Machine Co., Inc.

Controllers (Automatic Temperatures)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Cores (Alundum Furnace)
Norton Co.

Cornwall Stone
Harshaw, Fuller & Goodwin Co.
Pennsylvania Pulverizing Co.

Crucibles (Filter-Melting-Ignition)
Norton Co.
Potters Supply Co.

Crushers
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Hardinge Co.
Lancaster Iron Works, Inc.
Mueller Machine Co., Inc.

D

Decorating Supplies
Caulkins & Co., H. J.
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodman Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Decorating Kilns
Caulkins & Co., H. J.
Holcroft & Co.

Dental Furnaces
Caulkins & Co., H. J.

Discs (Alundum-Porous-Filter)
Norton Co.

Dishes (Alundum-Filtering-Ignition)
Norton Co.

Disintegrators
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Lancaster Iron Works, Inc.
Mueller Machine Co., Inc.

Dolomite
Innis, Speiden & Co.

Dryers (China Ware—Porcelain)
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

Dryers (Steam Pipe Rack)
Lancaster Iron Works, Inc.

Drying Machinery
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

"Proctor"

DRYING MACHINERY

for all Clay Products

Electrical Porcelain
Sanitary Ware
General Ware in Moulds
Dipped General Ware
Clay Rolls : Spark Plugs
Saggers : Tile
Refractories : Brick
Chemical Stoneware

PROCTOR & SCHWARTZ, INC.
PHILADELPHIA, PA.

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

E

Electrical Instruments
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Electric CO_2 Meters (Recorders)
Engelhard, Chas., Inc.

Electrical Porcelain Machinery
Mueller Machine Co., Inc.

Enameling Equipment, Complete
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.

Enameling Furnaces
Caulkins & Co., H. J.
Chicago Vitreous Enamel Product Co.
General Electric Co.
Holcroft & Co.
Parker Russell Co.
The Carborundum Co. (*Carboradiant*)
The Porcelain Enamel & Mfg. Co.
U. S. Smelting Furnace Co.
Vitro Mfg. Co.

Enameling Furnaces (Electric)
General Electric Co.

Enameling Muffles
Parker Russell Co.
The Carborundum Co.
(*Carbofrax*)

Enameling, Practical Service
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Enamels, Porcelain
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Engineering Service
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Parker Russell Co.

Equipment (Porcelain Enameling)
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co.

Extruding Machines (Lab. Use)
Chambers Brothers Co.

F

Feldspar
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co. (*Isco*)
Pennsylvania Pulverizing Co.
Roessler & Hasslacher Chemical Co.

Filtering Machinery
Mueller Machine Co., Inc.

Fire Brick
Parker Russell Co.
The Carborundum Co.

Flint
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co. (*Carrara*)
National Silica Co.
Pennsylvania Pulverizing Co.

Frit
Ferro Enamel Supply Co.
Porcelain Enamel & Supply Co.
Vitro Mfg. Co.

Fuel
Seaboard Fuel Corp.

Furnaces
Caulkins & Co., H. J.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Holcroft & Co.
Parker Russell Co.
The Carborundum Co. (*Carboradiant*)
The Porcelain Enamel & Mfg. Co.
U. S. Smelting Furnace Co.

Furnaces (Electrical)
Engelhard Chas., Inc.
General Electric Co.
Holcroft & Co.

G

Glazes and Enamels
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Granulators
Lancaster Iron Works, Inc.

The best grade base metal is cheapest in the long run

ENAMELING stock containing appreciable amounts of gases is expensive, even though the purchase price is low. Imprisoned gases cause enameling difficulties and losses.

The world's largest manufacturer of special analysis iron and steel sheets for exacting uses.

By ARMCO'S special manufacturing process, the gases along with other impurities, are virtually eliminated, leaving a dense, homogeneous structure that is especially adapted to the vitreous enameler's needs.

Uniformity throughout each sheet and each lot of sheets, is another important feature. ARMCO Ingot Iron is unequalled for producing an extremely high percentage of fine enameled ware, year after year.

Careful annealing minimizes warps and buckles, and the toothlike surface grips and holds the enamel.

Always the same—always ideal for enameling.

THE AMERICAN ROLLING MILL CO.
MIDDLETOWN, OHIO

Export: The ARMCO International Corporation
Cable Address—ARMCO, Middletown

ARMCO TRADE MARK INGOT IRON
The Purest Iron Made

BUYERS' GUIDE (continued)

Gold
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

H

Hearths
The Carborundum Co.
(*Carbofrax* heat treating)

Hygrometers (Electric)
Engelhard, Chas., Inc.

I

Impervite (Refractory and Hard Porcelain)
Engelhard, Charles, Inc.

Infusorial Earth
Innis, Speiden & Co.

Iron (Enameling)
American Rolling Mill Co.
The Mansfield Sheet & Tin Plate Co.
United Alloy Steel Corp.

J

Jiggers
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

K

Kaolin
Edgar Plastic Kaolin Co.
Harshaw, Fuller and Goodwin Co.
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Kilns (china, decorating)
Caulkins & Co., H. J.
Holcroft & Co.

Kiln Castings
Lancaster Iron Works, Inc.

Kryolith
Harshaw, Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.

L

Lehrs (Electric)
General Elec. Co.

Linings (Furnace-Refractory Block-Refractory Plate, Brick and Tile)
Norton Co.
The Carborundum Co.

M

Magnesite
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Manganese
Harshaw, Fuller & Goodwin Co.
Hy-Grade Manganese Co.

Metals (Porcelain Enameling)
American Rolling Mill Co.
The Mansfield Sheet & Tin Plate Co.
United Alloy Steel Corp.
(*See under Ball Mills*)

Mills
(*See under Ball Mills*)
(*See under Pebble Mills*)

Minerals
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Mixing Machines
Chambers Brothers Co.

Moulds (Brick)
Lancaster Iron Works, Inc.

Muffles (Furnace)
Norton Co.
The Carborundum Co. (*Carbofrax*)

Muriatic Acid
Harshaw Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

N

Nitrates (Cobalt, Sodium)
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

O

Oil Burners
Best, W. N. Corp.

Opacifiers
Harshaw, Fuller & Goodwin Co.
Titanium Alloy Mfg. Co.

Operators (Coal)
Seaboard Fuel Corp.

Oxides
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Metal & Thermit Corp.
Paper Makers Importing Co., (Inc.)
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

This Hits Your Pocket Nerve

1. Actual cost figures in 1925 show that the average three-furnace enameling plant can save at least

A Thousand Dollars a Month

by using OPAX.

2. Had OPAX been discovered first there would be no other opacifier on the market.

3. OPAX is not a mixture, not a substitute, not a secret compound.

4. OPAX is chemically definite, uniform, a domestic product, always available at a known price, and has every commercial and technical foundation for being

The Ultimate Opacificer

5. Overlooked or delayed profits pay no dividends, and the New Year gives you the chance to start right for bigger profit figures in your next annual financial statement.

The Titanium Alloy Manufacturing Company

Works at Niagara Falls, N. Y.

Ceramic Materials Department

R. D. Landrum, General Manager

6007 Euclid Ave. : : : : Cleveland, Ohio

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

P

Pans (Wet and Dry)
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Pebble Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pins
Potters Supply Co.

Placing Sand
Pennsylvania Pulverizing Co.
National Silica Co.
United Clay Mines Corp.

Plate Feeders
Chambers Brothers Co.
Hadfield-Penfield Steel Co.

Plates (Filter)
Norton Co.

Porcelain Enameling Service, Practical
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Porcelain Enamels
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Potash (Carbonate)
Innis, Speiden & Co.

Pottery Machinery
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Pug Mills
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Lancaster Iron Works, Inc.
Mueller Machine Co., Inc.

Pulverizing Machinery
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pulverizing Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pumps
Mueller Machine Co., Inc.

Pyrometers (Indicating)
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometers (Recording)
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometer (Switches)
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Engelhard, Charles, Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

R

Recording Instruments
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Recuperators
The Surface Combustion Co.

Refractories
The Carborundum Co.
Norton Co.
Parker Russell Co.
United Clay Mines Corp.

Refractory Materials
Parker Russell Co.
United Clay Mines Corp.

Regulators (Automatic Temperatures)
Engelhard, Charles, Inc.
Leed & Northrup Co.

S

Saggers
The Carborundum Co.
Norton Company
Potters Supply Co.

Founded 1869

B. F. DRAKENFELD & CO. INC.

50 Murray St. New York

LEPIDOLITE

For Flint and Opal Glasses

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Sagger Presses
Chambers Brothers Co.
Hadfield-Penfield Co.
Mueller Machine Co., Inc.
Watson-Stillman Co.

Screens
Newark Wire Cloth Co.

Selenite of Sodium
Drakenfeld and Co., B. F.
Harshaw, Fuller & Goodwin Co.
Vitro Mfg. Co.

Shippers (Coal)
Seaboard Fuel Corp.

Silica Brick
Parker Russell Co.

Silex Lining
Hardinge Co.

Sillimanite (Synthetic)
Norton Co.

Slabs (Furnace)
Norton Co.

Smelters
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Parker Russell Co.
U. S. Smelting Furnace Co.

Soda Ash
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Sodium Antimonate
Harshaw, Fuller & Goodwin Co.
Metal & Thermit Corporation
Vitro Mfg. Co.

Sodium Fluoride
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Spar
Eureka Flint and Spar Co.
Harshaw, Fuller & Goodwin Co.
Pennsylvania Pulverizing Co.

Spurs
Potters Supply Co.

Stacks
Lancaster Iron Works, Inc.

Stilts
Potters Supply Co.

Sulphuric Acid
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

T

Talc
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Tanks
Lancaster Iron Works, Inc.

Temperature Instruments (Measuring)
Engelhard, Charles, Inc.
Leed & Northrup Co.

Thermocouples
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Thermometers (Electric Resistance)
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Thimbles (Filtering Extraction)
Norton Co.

Tile Machinery (Floor and Wall)
Mueller Machine Co., Inc.

Tin Oxide
Harshaw, Fuller & Goodwin Co.
Metal & Thermit Corp.

Titanium
Titanium Alloy Mfg. Co.
Engelhard, Chas., Inc.

Tubes (Insulating)
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

Tubes (Pyrometer)
Engelhard, Charles, Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

To Members

American Ceramic Society:

The Central of Georgia Railway joins the other members and hosts of the American Ceramic Society in Georgia and the Southeast in assuring you of a cordial welcome at the Annual Convention in Atlanta, February 8-11, and the sidetrips to Macon and Wilkinson County, February 12-13.

We are cooperating in every effort for the success of the business sessions and the comfort and pleasure of our visitors.

Hospitable greetings await you.

Central of Georgia Railway

J. M. Mallory,
General Industrial Agent,
Savannah, Georgia.

BUYERS' GUIDE (continued)

V

Vacuum Pumps
Mueller Machine Co., Inc.

W

Wet Enamel
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co.
Ferro Enamel Supply Co.
Vitro Mfg. Co.

Whiting
Darkenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.

Winding Drums
Lancaster Iron Works, Inc.

Witherite
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Z

Zirconia
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

BALL
SAGGER } CLAY {
WAD

H. C. SPINKS CLAY CO.
NEWPORT, KY.
MINERS and SHIPPERS
Write for samples

Continous Tunnel Kilns Vitreous Enameling Furnaces
HOLCROFT & CO.
6545 Epworth Blvd. Detroit, Mich.

ALPHABETICAL LIST OF ADVERTISERS

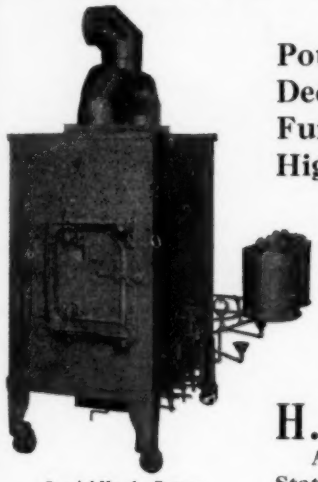
	PAGE
American Rolling Mill Co.	9
American Trona Corp.	5
Best, W. N. Corp.	24
Brown Instrument Co.	15
Carborundum Co.	30
Caulkins & Co., H. J.	18
Central of Georgia Railway	15
Chambers Brothers Co.	22
Chicago Vitreous Enamel Product Co.	5
Drakenfeld and Co., B. F., Inc.	13
Edgar Plastic Kaolin Co.	21
Engelhard, Charles, Inc.	25
General Electric Co.	33
Hadfield-Penfield Steel Co.	25
Harshaw, Fuller and Goodwin Co.	2
Holcroft & Co.	16
Hy-Grade Manganese Co., Inc.	21
Innis, Speiden & Co., Inc.	24
Journal of the Society of Glass Technology	19
Lancaster Iron Works, Inc.	28
Leeds & Northrup Co.	1
Macon Chamber of Commerce	35
Mansfield Sheet & Tin Plate Co.	28
McDanel Refractory Porcelain Co.	21
Metal & Thermit Corp.	Inside Back Cover
Montgomery Porcelain Products Co.	22
Mueller Machine Co., (Inc.)	18
National Silica Co.	29
Newark Wire Cloth Co.	5
Norton Co.	32
Paper Makers Importing Co. (Inc.)	31
Parker-Russell Co.	21
Pennsylvania Pulverizing Co.	24
Pennsylvania Salt Mfg. Co.	34
Philadelphia Drying Machinery Co.	36
Porcelain Enamel & Mfg. Co.	Outside Back Cover
Potters Supply Company	29
Proctor and Schwartz, Inc.	7
Professional Directory	26
Roessler and Hasslacher Chemical Co.	Inside Front Cover
Seaboard Fuel Corporation	20
Spinks, H. C. Clay Co.	16
Titanium Alloy Mfg. Co.	11
United Alloy Steel Corp.	27
United Clay Mines Corp.	21
U. S. Smelting Furnace Co.	3
Vitro Manufacturing Co.	23
Watson-Stillman Co.	22

(When writing to advertisers, please mention the JOURNAL)

The Revelation Kilns

OIL or GAS

Pottery Kilns, China and Glass Decorating Kilns, Enameling Furnaces, Dental and other High Heat Furnaces.



Special No. 6—Pottery

Thousands choose the Revelation Kiln.

Those who have used the Revelation Kiln longest are its most enthusiastic admirers.

H. J. CAULKINS & CO.

AMERICAN STATE BANK BUILDING
State and Griswold Sts., DETROIT, MICH.

CLAY MACHINERY!

SAGGER ROOM	SLIP HOUSE	GRINDING ROOM
Grog Pans	Blungers	Clay Crackers
Pug Mills	Agitators	Pulverizers
Sagger Presses	Lawns	Cage Grinders
Wad Mills	Pumps	Dust Screens
Grog Screens	Filter Presses	Pebble Mills
PRESS ROOM	**GREEN ROOM**	**GLAZE ROOM**
Tile Presses	Jiggers	Glaze Mills
Faience Presses	Pull Downs	Agitators
Porcelain Presses	Cleaning Wheels	Lawns
Dies & Equipment	Batting Machines	Pumps

THE MUELLER MACHINE CO.

TRENTON, N. J.

(When writing to advertisers, please mention the JOURNAL)

CLASSIFIED ADVERTISING

New Advertising Rates Effective January 1, 1926

Classified advertising for this page for positions wanted or positions vacant, can now be listed at the new rate of $1.00 for 35 words. Address the

Advertising Manager
American Ceramic Society
Lord Hall, O.S.U. Columbus, Ohio

Ceramic Engineer with four years of ceramic experience, now employed in another industry, would like to make connection in ceramic work. Interested in an opportunity to develop in a good organization. Address **Box 1218 American Ceramic Society, Lord Hall, O. S. U., Columbus, Ohio.**

POSITION WANTED

as plant executive or control engineer by ceramic engineer of broad training and experience whose specialty is porcelain. However, will consider position in any line. Address **Box 72/14 American Ceramic Society, Lord Hall, O. S. U., Columbus, Ohio.**

The Journal of the Society of Glass Technology

A quarterly Journal containing original papers and abstracts of papers covering the whole field of Glass Technology.

ANNUAL SUBSCRIPTIONS TO SOCIETY (Including Journal)

Ordinary Members	$ 7.00
Collective Members	15.00
Price per Number to non-Members	2.50
Price per volume (unbound) to non-Members	9.00

Address orders and inquiries to: The Secretary, Society of Glass Technology, The University, Sheffield, England.

(When writing to advertisers, please mention the JOURNAL)

COAL FACTS

Factors to Consider When Buying Ceramics Coals

1) The Reliability of the source of supply.

2) The Adaptability of the Coal for Your Specific Purpose.

3) The Promise of a Definite Delivery Date, and—

4) The Purchase Price.

Controlling, as we do, our own source of supply, we are able to take care of Factor No. 1.

Having Specialized for years in supplying Coal to Ceramic Plants and Potteries—there is no doubt about Factor No. 2.

If we make a promise of Delivery, we keep that promise. This takes care of Factor No. 3.

Fair dealing over a Period of Years, together with the fact that we are continually selling Coals to Ceramic Plants and Potteries at a fair Price—is the answer to Factor No. 4.

260 South Broad St. Philadelphia

SEABOARD FUEL CORPORATION

No. 1 Broadway New York City

(When writing to advertisers, please mention the JOURNAL)

THE PARKER RUSSEL CO.

ST. LOUIS

BUILDERS OF

RO-MACK Enameling Furnaces

HIGH TEMPERATURE FURNACES

For all Purposes

HIGH GRADE REFRACTORIES

TRADE MARK

Pyrometer Tubes—Protection Tubes—Combustion Tubes

McDanel Refractory Porcelain Company

Beaver Falls, Pennsylvania

UNUSUAL · SHAPES · OUR · SPECIALTY

HIGH GRADE

CLAYS

OF EVERY KIND—FOR EVERY PURPOSE

UNITED CLAY MINES CORPORATION TRENTON, N. J.

EDGAR CLAYS

Always as represented!

No matter when you buy our clays you will always find them running uniform and of a very high quality.

They are always as represented

EDGAR BROTHERS CO.

EDGAR PLASTIC KAOLIN CO. LAKE COUNTY CLAY CO.

METUCHEN, N. J.

USE "HY-GRADE" MANGANESE

for surface and body coloring. We pay special attention to our 200 mesh powder that will not "Cat Eye" in glazes.

We mine and very carefully prepare every pound of our own product.

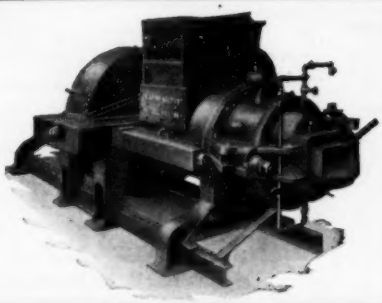
HY-GRADE MANGANESE COMPANY, Inc.

WOODSTOCK, VIRGINIA

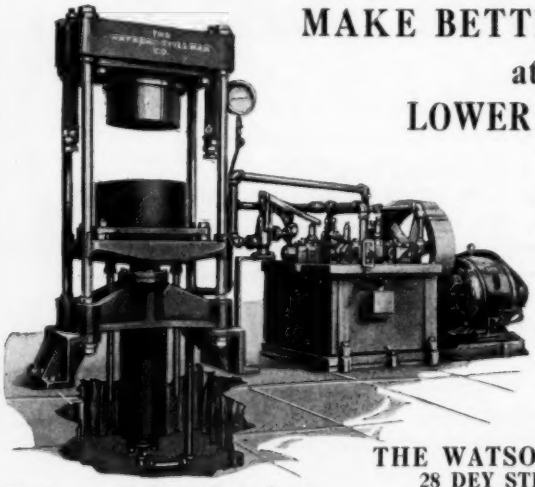
(When writing to advertisers, please mention the JOURNAL)

If you want pyrometer protection tube satisfaction
USE
Montgomery Hard Porcelain Pyrometer Tubes
All Sizes and Lengths for either Platinum or Base Metal Couples
The Best Liked and Most Largely Used
Protection Tubes on the Market today
If the manufacturer of your pyrometer equipment cannot supply you, write us direct.
TRADE MARK
MONTGOMERY PORCELAIN PRODUCTS CO.
FRANKLIN, OHIO, U. S. A. 10-22

Brick Making Machines
Crushers Grinders Mixers
Automatic Cutters
Chambers Bros. Co.
Philadelphia Pennsylvania



WATSON-STILLMAN SAGGER PRESSES
MAKE BETTER SAGGERS
at
LOWER COST



Showing a 50 Ton Sagger Press Outfit Complete equipped with dies for making Elliptical Sagger.

These Machines press saggers from solid wads of clay. Our sagger dies have no joints to work loose or open under pressure; this insures a homogeneous product and reduces to a minimum the losses in firing.

Write for Bulletins and full information

THE WATSON-STILLMAN CO.
28 DEY STREET, NEW YORK
Chicago, McCormick Building
Philadelphia, Widener Bldg.
Cleveland, Auditorium Garage Bldg.

Glass-Enamels-Pottery-Heavy Clay Products Refractories

and their fabrication, receive the most publicity through the Journal.

If you manufacture anything, for use in these various lines of ceramic activity, the place to advertise it is in the Journal, as it is *the most widely read ceramic publication on such subjects in the country.*

Let's have that advertisement right now for the NEXT Number of the Journal. You can't afford not to have your message in these issues which go to press on the 20th of each month.

Advertising Department

American Ceramic Department

Lord Hall, O.S.U. **Columbus, Ohio**

COLOR your products with our OXIDES —dependable—reliable

HIGHEST

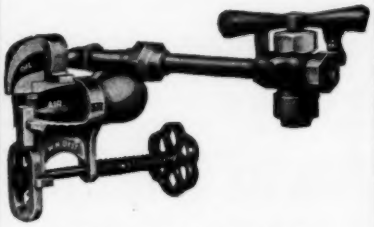
QUALITY

Sheet Steel and Cast Iron ENAMELS

For all Ceramic Industries CHEMICALS

(When writing to advertisers, please mention the JOURNAL)

W. N. BEST
Oil Burners



The BEST Since 1890

Write for catalogs and list of users in the Ceramic field

W. N. BEST Corporation
11 Broadway New York City

1816 CHEMICALS 1926

"Over a Century of Service and Progress"

South Dakata
FELDSPAR

An extremely high-grade Potash Spar ground in our own mills under constant and thorough chemical control.

Capacity up to 300 Tons Daily

We solicit your inquiries

INNIS, SPEIDEN & CO., Inc.
Importers, Manufacturers, Exporters
46 CLIFF STREET NEW YORK

Branches:
BOSTON PHILADELPHIA
CHICAGO CLEVELAND
GLOVERSVILLE

PENNSYLVANIA PULVERIZING CO.
LEWISTOWN, PA.

Pure Canadian Potash Feldspar
Potters Flint Placing Sand

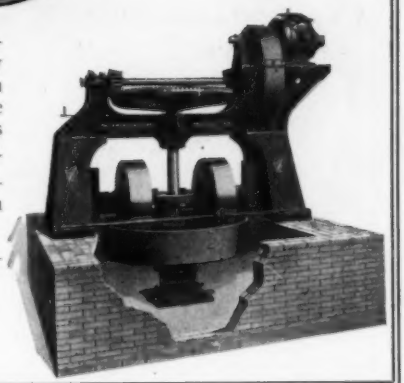
SALES OFFICE
323 Fourth Avenue
Pittsburgh, Pa.

THE CERAMIC INDUSTRY'S BEST ASSET

The best Asset of the Ceramic Industry is quality of product and quality of product is largely dependent on properly prepared Materials. The American Wet Grinding Pan does its work thoroughly, quickly and cheaply.

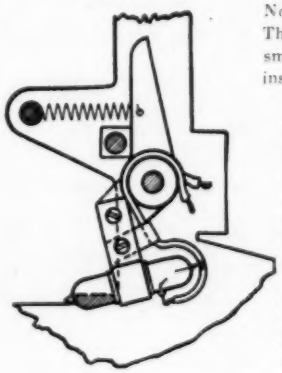
This is an unusually well built, dependable unit. Long on service. Light on power. Ask for Bulletin.

We build a complete line of machinery for Ceramic needs.



The Hadfield-Penfield Steel Co.
BUCYRUS, OHIO

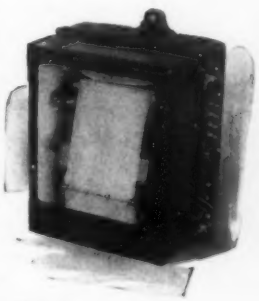
Mercury Switch Solves Problem



No more electrical contact troubles on pyrometer recorders. This sketch shows our new Mercury Contact Switch—the small glass bulb containing mercury. See the contact points inside the bulb at the right? See the mercury at the left?

When the bulb is tilted the other way the mercury envelopes the contact points and you have a flow of current. It is UNFAILING.

Ask for Bulletin No. 28 and learn about the OTHER many advantages of Engelhard Recorders.



Charles Engelhard, Inc.

30 Church Street NEW YORK CITY

Factory: Newark, N. J.

(When writing to advertisers, please mention the JOURNAL)

PROFESSIONAL DIRECTORY

THE SHARP-SCHURTZ CO.
Chemists for the Ceramic Industry
We have fully equipped laboratories at
Lancaster, Ohio, U. S. A.

KARL LANGENBECK
Consulting Ceramic Engineer
1625 Hobart St. N. W., Washington, D. C.
Competent men for responsible positions in the clay industries, available.

Lancaster Iron Buys Monitor Bi-Loop

Through the transaction just closed whereby the Lancaster Iron Works, Inc., have purchased nine acres of industrial property on the Harrisburg Pike and on the Penna. R. R. that company has laid plans to become the biggest builders of Tanks and Steel Plate Construction in the East.

The new purchases of the Lancaster Iron Works include the ground, buildings, machinery, tools and equipment of the Monitor Bi-Loop Radiator Company.

The reason given for the purchase by The Lancaster Iron Works, Inc., is the fact that the building program at the company's lower plant, Hager and Water Sts., is completed and that there is so much business on hand that satisfactory deliveries cannot be made without these additional facilities.

The Lancaster Iron Works will immediately complete the new steel boiler shop recently erected by the Monitor Company, install new cranes and production will be started in that plant within a week. This will give them at least 50% increase in shop capacity.

The addition of the Monitor products to its list will further increase the scope of the market absorbing Lancaster Iron Works, Inc. products.
The Lancaster Iron Works, Inc., incorporated in Pennsylvania in 1910, is one of the largest builders of Tanks and Steel Plate Construction in the East.

Due to the seasonal demand for Tank and Steel Plate Construction and being equipped to construct brick making machinery, the Arnold Creager Company of New London, Ohio, was acquired in 1920.

Since that time the Lancaster Iron Works, Inc., has become the largest manufacturer of Clay Working and Brick Making Machinery in the country. In addition the Lancaster Iron Works, Inc., owns a large interest in the Lancaster Brick Company, manufacturers of Sand Molded Building Brick. Through a subsidiary, F. J. Ryan & Company of Philadelphia, Industrial Furnace Builders and Heat Treating Engineers, a large volume of business in castings, plate work, etc., is obtained.

The Monitor Bi-Loop Company, which was organized more than a year ago and which has built up such a large business, will continue as a selling agency under the direction of Fred Vaux.

The Fearless Inspection of Toncan Means Good Enameling Results

The extreme care expended upon the making of Toncan Enameling sheets, from the special treatment in the open-hearth furnace through all the processes of bar and sheet rolling, cold-rolling, annealing and pickling, is checked by a system of inspection which has few equals in severity.

This fearless inspection costs money. Sheets which might conceivably pass for perfect nearly anywhere are rejected for imperfections which are only apparent to the highly trained eye.

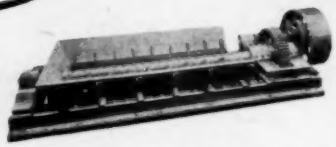
The result is a smoothness of production for the enameler, a freedom from culls, which can be attained only by the use of Toncan, for Toncan sheets have a uniform high quality rarely found in these days of quantity production.

TONCAN METAL

UNITED ALLOY STEEL CORPORATION
CANTON, OHIO

New York	Chicago	San Francisco
Syracuse	Detroit	Indianapolis
Cleveland	Pittsburgh	Portland
	Philadelphia	

TONCAN ENAMELING SHEETS



Lancaster Granulators come in sufficient size and strength for any capacity plant. They stand up under continuously heavy duty without shut-downs for repair or replacement.

Full Details on request

Better Clay Mixing With This Heavy Duty Granulator

Don't thrust upon your pug mill the entire burden of preparing the clay. Complete tempering requires auxiliary machinery. Lancaster Heavy Duty Granulators materially assist additional clay working machinery by breaking up large lumps of dry clay and thoroughly mixing the entire mass.

The Lancaster Granulator makes possible a better clay product—for no matter how clay may vary from the top to the bottom of the bank—it is reduced to a uniform quality in this machine.

Let Lancaster Engineers help solve your clay preparing problem

LANCASTER IRON WORKS, Inc.
LANCASTER, PENNSYLVANIA
BRICK MACHINERY DEPARTMENT JAMES P. MARTIN, Manager

WABIK QUALITY M PRODUCTS METAL

After an exhaustive study of the requirements of the Enameling Industry we are producing:

WABIK METAL SPECIAL VITREOUS ENAMELING SHEETS

Unlike ordinary steel sheets, warping and blistering is reduced to a minimum, thus increasing the Enameler's output and profit.

Many of the leading plants now recognize "WABIK METAL" as the supreme stock for that beautiful permanent lustre which is so essential in Table Tops, Stove Parts, Refrigerator Parts, Signs, etc.

THE MANSFIELD SHEET & TIN PLATE CO.
MANSFIELD, OHIO

(When writing to advertisers, please mention the JOURNAL)

SERVICE TO POTTERS

We Manufacture—
- PINS
- STILTS
- THIMBLES
- SPURS
- SAGGERS
- CRUCIBLES
- TILE for Decorating kilns

We Sell—
- BALL CLAY
- SAGGER CLAY
- WAD CLAY
- GROUND FIRE CLAY
- BITSTONE
- FIRE BRICK
- IMPORTED PARIS WHITE

THE POTTERS SUPPLY COMPANY
EAST LIVERPOOL, OHIO

The National Silica Co.
OREGON, ILL.

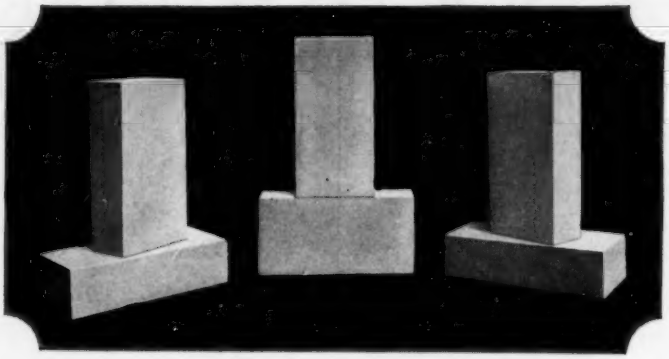
Producers and Pulverizers of

FLINT

exclusively for

Pottery Purposes

99.97% Pure Silica 140 Silk Lawn Test



INDUSTRY HAS BEEN WAITING FOR **INSULFRAX**

The New High Temperature Insulating Brick

AN Insulating Brick that shows little or no shrinkage at high temperatures—that will not soften or disintegrate—an Insulating Brick of remarkable mechanical strength—this has been one of the crying needs of industry.

And the Insulfrax Brick fills this need.

In a word or two it is an Insulating Brick having real refractory properties.

The melting point of this brick is above 3100° F.

Industry never before has had an Insulating Brick of such high refractoriness.

Its thermal conductivity is about ⅓ of fireclay and 1/30 that of Carborundum refractories.

Its mechanical strength is indicated by the fact that it will withstand 40 pounds pressure to the square inch at 2550° F.

Its shrinkage is almost negligible up to 2550° F.

Insulfrax has *all* of the properties of the ideal insulating brick—extremely porous—light in weight—yet durable.

Insulfrax Saves Heat in Annealing Ovens, Boiler Furnaces, Coke Ovens Electric Furnaces, Heat Treating Furnaces, Kilns, Oil Stills, Etc.

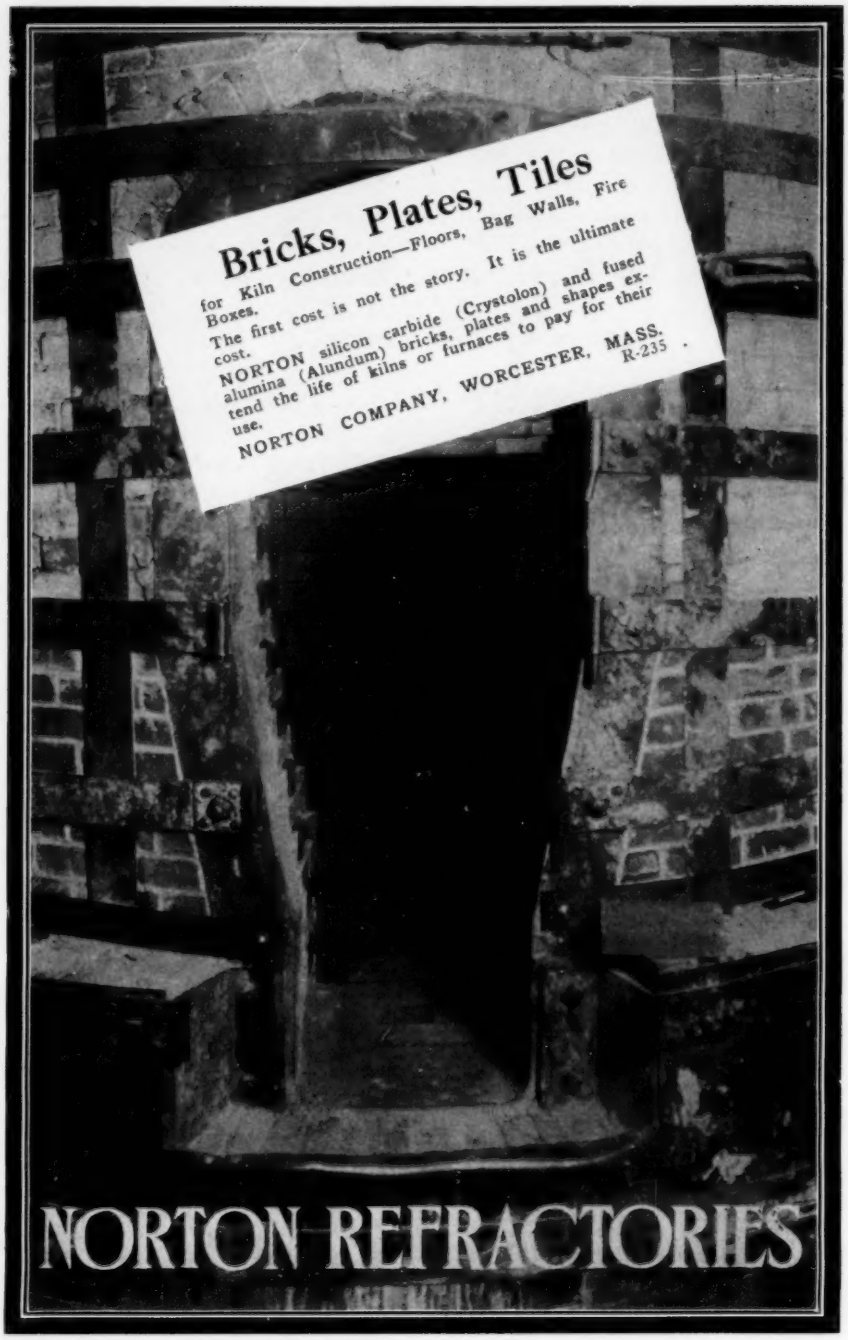
GLAD TO SEND YOU SAMPLES

THE CARBORUNDUM COMPANY, NIAGARA FALLS, N.Y.

New York - Chicago - Boston - Philadelphia - Cleveland - Detroit
Cincinnati - Pittsburgh - Milwaukee - Grand Rapids
Williams & Wilson, Ltd., Montreal

WE extend to each and every member of the American Ceramic Society, also to every manufacturer of ceramics throughout the United States and Canada our heartiest best wishes, and we hope that the year 1926 will be one of the most prosperous in their history.

PAPER MAKERS IMPORTING CO., *Inc.*
EASTON, PA.


Bricks, Plates, Tiles
for Kiln Construction—Floors, Bag Walls, Fire Boxes.
The first cost is not the story. It is the ultimate cost.
NORTON silicon carbide (Crystolon) and fused alumina (Alundum) bricks, plates and shapes extend the life of kilns or furnaces to pay for their use.
NORTON COMPANY, WORCESTER, MASS.
R-235
NORTON REFRACTORIES

(When writing to advertisers, please mention the JOURNAL)

Electric vitreous enamel furnace equipped with G-E Direct-Heat Units and Automatic Temperature Control.

Electric Vitreous Enameling

Improving the product and reducing the cost of production are actual facts in the application of electric heat thru G-E Direct-Heat Units to vitreous enamel furnaces.

G-E Direct-Heat Units in your furnace mean no muffles to sag or break—no combustion gases and dirt—elimination of rejects due to spoilage by furnace—decreased labor for operating—and minimum upkeep on equipment.

G-E Direct-Heat Units radiate quick, clean heat direct to the charge—electric heat so uniformly distributed throughout the furnace, and so accurately controlled that the maximum speed and highest quality of vitreous enamel are obtained.

G-E Industrial Heating Specialists will gladly help you work out a better vitreous enamel furnace plan—through the proper application of electric heat.

General Electric Company
Schenectady, N. Y.
Sales Offices in all large cities

GENERAL ELECTRIC

GREENLAND KRYOLITH

NATROMA HYDRATE and OXIDE ALUMINA

PENNSYLVANIA SALT MANUFACTURING COMPANY

Executive Offices: Philadelphia, Pa.

Works: Philadelphia and Natrona, Pa. Wyandotte and Menominee, Mich.

Representatives: Pittsburgh St. Louis New York Chicago

This is the last call for your advertising copy and layout if you want it in the convention issue. Send it in at once.

Advertising Department

AMERICAN CERAMIC SOCIETY

Lord Hall, O. S. U. Columbus, Ohio

(When writing to advertisers, please mention the JOURNAL)

Going to the CERAMIC CONVENTION?

then don't fail to see the Wonderful Clay Deposits *at Macon*

IN central Georgia, only a short ride from Atlanta, are deposits of kaolin and other clays unequalled in quality, quantity and proximity to markets by anything in America!

At the convention of the American Ceramic Society in Atlanta, February 8-15, you will have an opportunity to inspect Georgia clays which have proven so superior in the manufacture of white ware, sanitary wares, floor and wall tile, electrical porcelain and refractories. You will see great mines in operation, employing the latest methods—yet hardly scratching the surface of the immense deposits. Here is an opportunity for you to get first-hand information as to why clay products can be manufactured in Georgia at lower production cost and transportation cost than in any other section.

The City's Yours

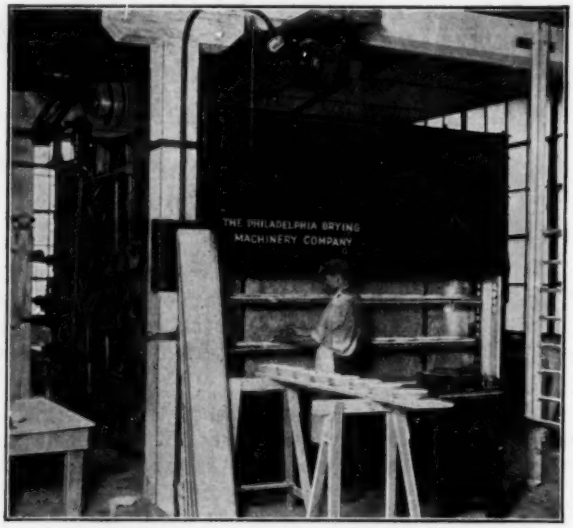
Make This Pleasure Trip!

As a feature of the convention program there will be a trip to Macon and the Georgia clay belt. Macon is one of the older cities in the United States and has many places of historic interest. You will find Southern hospitality and entertainment at its best! We invite you personally to come see us and take advantage of this trip.

Chamber of Commerce
MACON GEORGIA

HURRICANE DRYERS

FOR CERAMICS



In the drying of Ceramics of all kinds "HURRICANE" stands for maximum output per square foot of floor space; for guaranteed capacity; for lower steam, power and labor costs.

There is a "HURRICANE" Dryer for your individual requirements, a dryer built on broad experience in meeting most effectively many similar problems.

Tunnel Truck System - Automatic, Continuous Dryers, "Humidity Dryers".

THE PHILADELPHIA DRYING MACHINERY COMPANY

Builders of Ceramic Dryers

Stokley St. above Westmoreland

HURRICANE *Ideal Drying Every Day*

Philadelphia, Pennsylvania

Canadian Agents:
Whitehead, Emmans, Ltd., Montreal
New England Agency:
Hurricane Engineering Company, 53 State St., Boston, Mass.

M & T
TIN OXIDE

Is preferred by foremost firms throughout the country making enamels, terra cotta, faience, tiles, sanitary pottery and art pottery.

A uniform product, free from impurities, and with unexcelled covering power.

We welcome inquiries, and will glady send samples for test purposes.

Exclusive Agents for

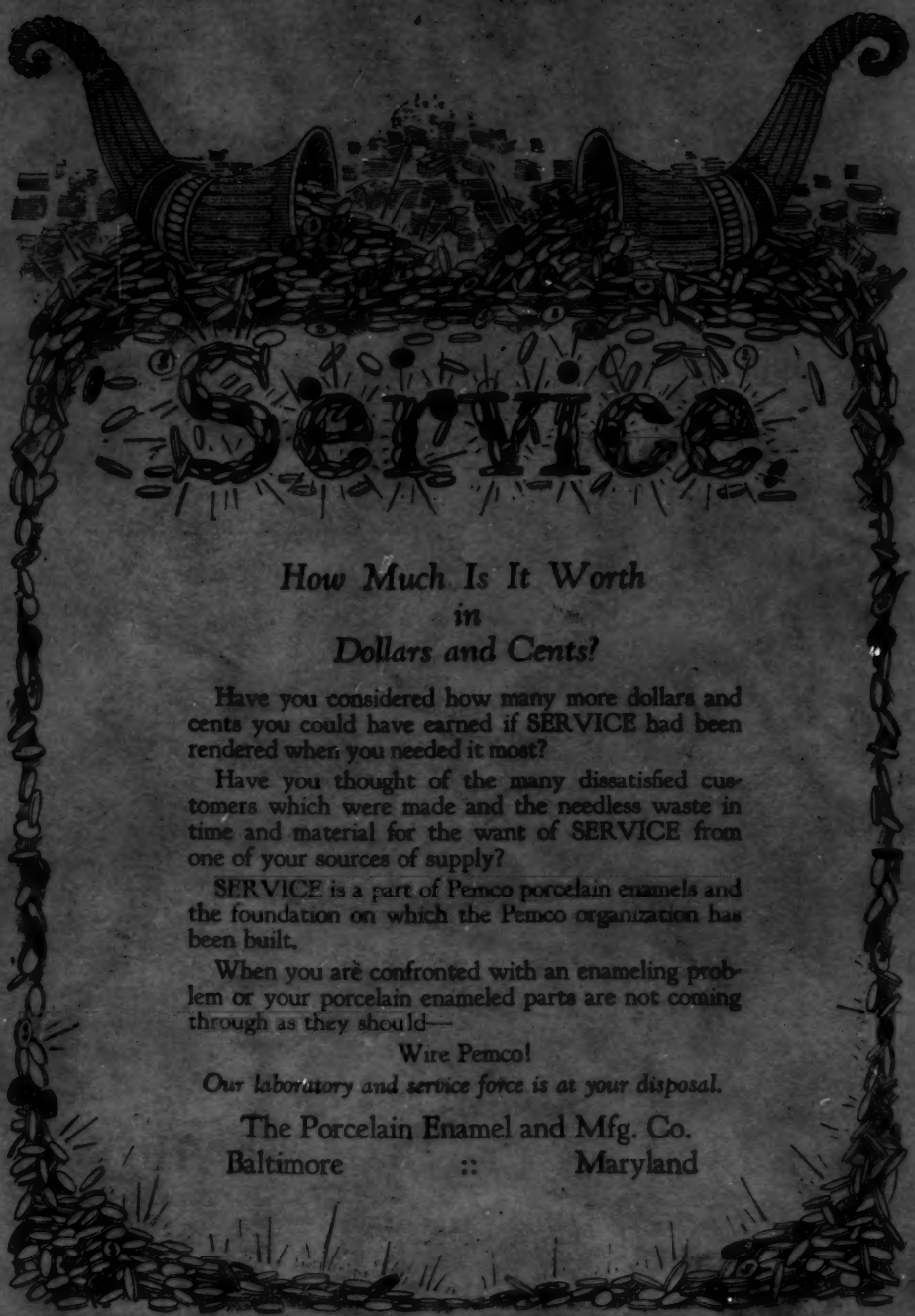
Johnson-Porter Enamel Clays

By giving exceptionally good results in floating enamel these clays are rapidly supplanting foreign enamel clays.

METAL & THERMIT CORPORATION

Ceramic Department
Homer F. Staley, Mgr.

120 Broadway
New York



How Much Is It Worth in Dollars and Cents?

Have you considered how many more dollars and cents you could have earned if SERVICE had been rendered when you needed it most?

Have you thought of the many dissatisfied customers which were made and the needless waste in time and material for the want of SERVICE from one of your sources of supply?

SERVICE is a part of Pemco porcelain enamels and the foundation on which the Pemco organization has been built.

When you are confronted with an enameling problem or your porcelain enameled parts are not coming through as they should—

Wire Pemco!

Our laboratory and service force is at your disposal.

The Porcelain Enamel and Mfg. Co.
Baltimore :: Maryland